PB90-110115

Reranking of Area Sources in Light of Seasonal/Regional Emission Factors and State/Local Needs

Alliance Technologies Corp., Chapel Hill, NC

Prepared for:

Environmental Protection Agency, Research Triangle Park, NC

Aug 89

U.S. Department of Commerce
National Technical Information Service
NTIS

PB90-110115

EPA/600/7-89/008
August 1989

RERANKING OF AREA SOURCES IN LIGHT OF SEASONAL/REGIONAL EMISSION FACTORS AND STATE/LOCAL NEEDS

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Contract No. 68-02-4396
Work Assignment No. 20

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U.S. DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL INFORMATION SERVICE
SPRINGFIELD, VA. 22161

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
EPA/600/7-89/008		PB90 110115/AS

4. TITLE AND SUBTITLE	5. REPORT DATE
Reranking of Area Sources in Light of Seasonal/ Regional Emission Factors and State/Local Needs	August 1989
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT NO.
Sharon L. Kersteter	
9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT NO.
Alliance Technologies Corporation 100 Europa Drive Chapel Hill, North Carolina 27514	11. CONTRACT/GRANT NO.
	68-02-4396, Task 20
12. SPONSORING AGENCY NAME AND ADDRESS	13. TYPE OF REPORT AND PERIOD COVERED
EPA, Office of Research and Development Air and Energy Engineering Research Laboratory Research Triangle Park, NC 27711	Task Final;
	14. SPONSORING AGENCY CODE
	EPA/600/13

15. SUPPLEMENTARY NOTES AEERL project officer is Michael Kosusko, Mail Drop 62B, 919/541-2734.

16. ABSTRACT

The report gives results of an effort to provide a better understanding of air pollution area sources and their emissions, to prioritize their importance as emitters of volatile organic compounds (VOCs), and to identify sources for which better emission estimation methodologies are needed. Area sources in general and area source solvent categories were prioritized based on annual and seasonal emissions and EPA Regional emission dependencies (i.e., certain categories, such as forest wildfires, were identified as categories in which activity accurs significantly more in one Region than in others and therefore show Regional emission dependencies). Factors affecting the variability of each area source category were also identified. Inventory assumptions and seasonal/Regional factors were documented and discussed.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Pollution Organic Compounds Volatility Solvents Inventories	Pollution Control Stationary Sources Volatile Organic Compounds	13B 07C 20M 11K 15E

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS (This Report)	21. NO. OF PAGES
Release to Public	Unclassified	114
	20. SECURITY CLASS (This page)	22. PRICE
	Unclassified	

EPA Form 2220-1 (9-73)

PREFACE

Although the Clean Air Act deadline for attaining the national ambient air quality standard (NAAQS) for ozone was December 31, 1987, 68 metropolitan areas failed to attain this standard. Controls to reduce emissions of ozone precursor pollutants (VOC, NO_x, and CO) have been placed on many stationary point and mobile sources, but to date many area sources have not had any controls applied to them even though they are known to be significant sources of VOC emissions. Development of effective and feasible emissions control strategies for area sources should be based on adequate information on the potential effectiveness of these controls for reducing emissions.

This task was designed to provide a better understanding of area sources and their emissions, to prioritize their importance as VOC emitters, and to identify sources for which better emission estimation methodologies are needed. Area sources in general and area source solvent categories were prioritized based on annual and on seasonal emissions and seasonal and EPA Regional emission dependencies (i.e., certain categories, such as forest wildfires, were identified as categories in which activity occurs significantly more in one Region than in others and therefore show Regional emission dependencies). Specific factors affecting the variability of each area source category were also identified. Inventory assumptions and seasonal/Regional factors were documented and discussed.

NOTICE

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ABBREVIATIONS

CO - carbon monoxide

CTG - Control Techniques Guidelines

EPA - U.S. Environmental Protection Agency

ITC - U.S. International Trade Commission

LTO - landing and takeoff cycle

NAAQS - National Ambient Air Quality Standard

NAPAP - National Acid Precipitation Assessment Program

NECRMP - Northeast Corridor Regional Modeling Project

NEDS - National Emissions Data System

NO_x - nitrogen oxides

OAQPS - U.S. EPA, Office of Air Quality Planning and Standards

RACT - Reasonably Available Control Technologies

ROMNET - Regional Oxidant Modeling for Northeast Transport

SCC - source classification code

SIC - Standard Industrial Classification code

SIP - State Implementation Plan

TAM - Temporal Allocation Module

VOC - volatile organic compound

ENGLISH TO METRIC CONVERSION FACTORS

1 ton = 907.1860 kilograms

1 foot = 0.3048 meters

1 gallon = 3.785 liters

1 cubic foot = 28.317 liters

1 megawatt = 1 million Joules/second
= 948.6 BTU/second

1 BTU = 1055 Joules

degrees Fahrenheit = (1.8 x ^{o}C) + 32

1 mile/hour = 1.609 kilometers/hour

1.0 INTRODUCTION

1.1 PURPOSE OF PROJECT

The Clean Air Act deadline for attaining the national ambient air quality standard (NAAQS) for ozone was the end of 1987. The failure of 68 U.S. metropolitan areas to attain the ozone standard by December 31, 1987 was one of the major environmental issues of 1988. Ozone is photochemically produced in the atmosphere when volatile organic compounds (VOC) are mixed with nitrogen oxides (NO_x) and carbon monoxide (CO) in the presence of sunlight. To develop and implement an effective ozone control strategy, information must be compiled and reviewed on the sources of these precursor pollutants.

Although substantial emission controls have been placed on many stationary point and mobile sources and significant improvements have been made, attainment of the ozone standard has not occurred in many metropolitan areas. Many area sources have not yet had any controls applied even though they are known to be substantial sources of VOC emissions. To determine the area source categories on which to place emission controls, area sources must be evaluated to identify those categories where controls can be both effective and feasible. Regional and seasonal patterns of emissions should also be investigated, as these characteristics can influence the effectiveness of the emission controls.

The purpose of this task is to develop a better understanding of area sources and their emissions, to prioritize their importance as VOC emitters, and to identify sources for which better emission methodology is needed. Several specific goals for this project were identified at the project's inception and others were added as the project evolved. The goals of this project are as follows:

- Prioritize area sources; identify seasonal and regional emission dependencies.
- Prioritize solvent categories for future work, seasonally and regionally, using tonnages.

- Identify specific factors affecting the variability of each area source category.

- Document inventory assumptions and seasonal/regional factors and discuss reliability pointing out the weakest and most important assumptions.

Sections 1.2.1 through 1.2.4 provide brief descriptions of the work performed to achieve each goal.

1.2 WORK PLAN GOALS

The goals listed above were designed to build upon one another so that an improved procedure and/or test case for estimating emissions from a given area source category can be developed. The work outlined below (and discussed in greater detail elsewhere in this report) leads up to that point.

1.2.1 Prioritize Area Sources

Area sources were ranked from highest emissions contributors to lowest for U.S. Environmental Protection Agency (EPA) Regions I, II, VI, and IX on both an annual basis and on a seasonal basis (summertime emissions). These four Regions were chosen for several reasons: (1) to provide a cross-section of emissions and rankings across the country; (2) because of the ongoing work on area sources and their emissions which is being done by the States in these Regions; and (3) because each of these Regions contains recognized ozone nonattainment areas. Two sets of seasonal factors, one from the NAPAP (National Acid Precipitation Assessment Program) methodology and one from the ROMNET (Regional Oxidant Modeling for Northeast Transport) process, were used. Rankings were compared within States and among States and Regions.

1.2.2 Prioritize Solvent Categories

This goal was added as a result of the work outlined in Section 1.2.1. The NEDS (National Emissions Data System) Evaporative Loss - Solvents Purchased category (source classification code (SCC) 053) was disaggregated

into the NAPAP solvent categories 078 through 101 and reported by State and Regional totals for EPA Regions I, II, VI, and IX. These categories were ranked from high to low with respect to annual emissions and were reranked in light of seasonal variations using ROMNET and NAPAP seasonal adjustment factors.

1.2.3 Identify Variability and Analyze Validity of Estimates

NEDS/NAPAP-generated emissions estimates for four counties in Texas were compared to estimates generated in an emissions trends analysis for the same four counties using methodologies found in Procedures for the Preparation of Emission Inventories for Precursors of Ozone.[1] The "top-down" procedures used by NEDS/NAPAP were compared with the "bottom-up" procedures found in Reference 1 for the categories where the emissions estimates differed significantly.

The bases for the development of the NAPAP and ROMNET seasonal adjustment factors were reviewed and compared.

1.2.4 Document Inventory Assumptions and Reliability

Due to resource constraints, work performed in this section was limited to identification and discussion of the basis for NAPAP solvent allocation methodology and emission estimates for three solvent categories: SCC 082 - Architectural Coatings; SCC 093 - Miscellaneous Surface Coatings; and SCC 095 - Miscellaneous Solvent Use. The original algorithm used in the NAPAP methodology and recent updates to the methodology were discussed.

1.3 CONTENTS OF DOCUMENT

Discussions of the work performed as part of this task are found in Sections 2.0, 3.0, and 4.0. Section 2.0 provides a discussion of the methodology used to prioritize the area source categories and presents the results in tables and in pie charts. Annual emissions for the seven largest nonhighway area source categories are adjusted to represent summertime (ozone season) emissions and the categories are reranked using these summer

estimates. Both annual emissions and seasonal (summertime) emissions are analyzed and summarized.

In Section 3.0, the emissions estimates are analyzed for variability and validity. The different estimation methodologies and seasonal adjustment factors are discussed. The discussion in Section 4.0 focuses on the basis for the NAPAP emission estimates for three area source solvent categories. The reliability of these estimates is addressed in this section. Section 5.0 contains a summary of the analyses performed in this work assignment and the conclusions and recommendations drawn from the analyses. References used in this project and document are found in Section 6.0. Appendix A contains a discussion of the origin of the 1971 solvent consumption estimates which were used as the basis for the NAPAP solvent allocation methodology.

1.4 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations have resulted from the analyses performed for this project. These are discussed in greater detail in Section 5.0.

- Among States and Regions, the ranking of area source categories based on annual emissions consistently shows the evaporative loss categories (Evaporative Loss - Solvents Purchased and Evaporative Loss - Gasoline Marketed) and Residential Fuel - Wood to be the top three categories. Adjustment for the ozone season results in a drop in the ranking of residential wood combustion; however, the evaporative loss categories still show the highest rankings overall.

- Further breakdown of the Evaporative Loss - Solvents Purchased category shows that the miscellaneous solvent categories (Miscellaneous Solvent Use and Miscellaneous Surface Coating) rank first and second, respectively, for the majority of States and Regions covered in this study. These rankings remained the same for both annual and summer (ozone season) emissions. In fact, seasonal

adjustments to the annual emissions resulted in almost no change in the rankings of solvent categories for all States and Regions.

- Comparisons of different methodologies used to estimate emissions from certain area sources showed that results of the different methodologies can vary drastically. In general, the use of local data to estimate emissions through "bottom-up" methodologies provides more accurate and reliable data than the use of State or national data allocated to the county or local area ("top-down" methodologies). "Bottom-up" methodologies, however, often require greater resources, both in terms of time and money, than "top-down" methodologies.

- Use of seasonal adjustment factors showed changes in ranking from the annual rankings of some categories. While actual tonnages may differ, use of two different groups of seasonal adjustment factors, NAPAP and ROMNET, resulted in the same seasonal rankings in almost all cases. The availability of additional ROMNET seasonal adjustment factors may cause minor differences in seasonal rankings as compared to the NAPAP rankings.

- Investigation into the basis for estimating emissions from the NAPAP categories Miscellaneous Solvent Use (SCC 095), Miscellaneous Surface Coating (SCC 093), and Architectural Surface Coating (SCC 082) showed the need for additional work to better characterize these categories. Work is currently being done to improve the NAPAP methodology for distribution of solvent emissions. Additional work may be needed to create or improve emissions factors for other area source categories.

- Additional studies should be performed to compare emissions estimates generated using the EPA State Implementation Plan (SIP) guidance and the NEDS/NAPAP emissions estimates. If the findings of the additional studies support the findings of this project, all of

the estimation methodologies should be reviewed and revised as warranted.

- Further disaggregation of the Miscellaneous Solvent Use category (SCC 095), especially the commercial/consumer solvent use portion of this category, should be attempted. Emphasis should be placed on how the solvents are apportioned to the various subcategories and on what can be done to improve this process. In addition, the updates to and revisions of the NAPAP methodology for the 1990 NAPAP inventory should be followed closely.

2.0 AREA SOURCE CATEGORY PRIORITIZATION

2.1 METHODOLOGY

Area source categories for each State in U.S. Environmental Protection Agency (EPA) Regions I, II, VI, and IX (with the exception of Hawaii in Region IX for which no National Emissions Data System (NEDS) data were available) were ranked from highest emitters to lowest emitters based on 1985 NEDS annual data. The top seven categories were identified for each State and Region by: (1) total number of tons of volatile organic compounds (VOC) in the category; (2) percent of total area source VOC excluding mobile source emissions; and (3) percent of total area source VOC including mobile source emissions. Summertime, or ozone season, emissions were determined for the same top seven categories for each State by applying National Acid Precipitation Assessment Program (NAPAP) seasonal (summer) adjustment factors. The top seven categories were then reranked for each State and Region in light of the seasonal variations.

Table 2.1-1 shows the 1985 NAPAP area source categories, their associated Source Classification Code (SCC) numbers, and the units in which emissions for the category are expressed.

2.2 RANKING USING ANNUAL EMISSIONS

The category showing the greatest emissions in all Regions was the NEDS category Evaporative Loss - Solvents Purchased. This category encompasses solvents used in small degreasing, dry cleaning, graphic arts, and auto body repair operations, as well as small industrial manufacturing operations, architectural surface coatings, and other miscellaneous surface coating and solvent use categories. In all Regions and in all States except Maine and Vermont (Region I) and New Mexico (Region VI), the Evaporative Loss - Solvents Purchased category ranked first among nonhighway area source emissions. The Residential Fuel - Wood category ranked first in Maine, Vermont, and New Mexico, followed next by the Evaporative Loss - Solvents Purchased category.

Tables 2.2-1 through 2.2-4 show the top seven nonhighway area source categories based on annual emissions. Figures 2.2-2, 2.2-4, 2.2-6, and

2.2-8 display the same information for the Regions in pie chart format. Figures 2.2-1, 2.2-3, 2.2-5, and 2.2-7 are also pie charts and show the breakdown of categories based on annual emissions, however, these pie charts include the highway mobile source category in addition to the top seven nonhighway area source categories.

Top seven categories across the four Regions include: Evaporative Loss - Solvents Purchased; Residential Fuel - Wood; Evaporative Loss - Gasoline Marketed; Gasoline Off-Highway Vehicles; Residential On-Site Incineration; Gasoline Vessels; Residential Open Burning; Cutback Asphalt; and Forest Wildfires. The top three categories in all Regions are Evaporative Loss - Solvents Purchased, Residential Fuel - Wood, and Evaporative Loss - Gasoline Marketed. (The Gasoline Marketed category covers evaporative losses of VOC from operations such as filling losses from loading underground storage tanks at service stations and spillage and filling losses from filling automobile tanks.) These three categories show little Regional variation in ranking. The remaining categories, however, do exhibit some Regional variation. For example, in Region IX forest wildfires rank sixth in VOC emissions, but do not rank among the top seven categories in any other Region reviewed for this task.

2.3 RERANKING USING SEASONAL EMISSIONS

The top seven categories were reranked for each State and Region by applying the seasonal adjustment factors used in the NAPAP inventory. The seasonal adjustment factors were taken from the NAPAP temporal allocation factor file which is part of the Temporal Allocation Module (TAM). Factors are given by State within each NAPAP SCC. Factors for SCC categories 001 through 099 (excluding categories 053, 057-059, 063, and 065-070) are available in the TAM factor file. The methodologies used to develop the seasonal adjustment factors are discussed briefly in Section 3.3.2 and are described in greater detail in Development of the 1980 NAPAP Emissions Inventory.[2]

Certain categories, such as Residential On-Site Incineration (SCC 021), Residential Open Burning (SCC 024), Railroad Locomotives (SCC 045), Military Aircraft (SCC 046), Diesel Oil Vessels (SCC 050), and Gasoline Marketed (SCC 054), display an equal distribution of activity over all four seasons and have

the same adjustment factor for all States. Other categories, such as Commercial Aircraft (SCC 048), Forest Wildfires (SCC 060), Managed Burning - Prescribed (SCC 061), and Agricultural Field Burning (SCC 062), do not show an equal distribution of activity over all four seasons (i.e., these categories show some seasonal variation) but their distributions of activity over the seasons are the same from State to State.

Categories showing greater summertime activity as compared to the other three seasons include: Gasoline Off-Highway Vehicles (SCC 039), with an average factor of 0.329 for the sixteen States in this study; Diesel Off-Highway Vehicles (SCC 044), with an average of 0.334; Commercial Aircraft (SCC 048), with a factor of 0.260 for all States; Gasoline Vessels (SCC 052), with an average of 0.406; and Forest Wildfires (SCC 060) with a factor of 0.500 for all States. A summer adjustment factor of 0.329 for a source category indicates that 32.9 percent of the activity in that category occurs during the summer season.

The major difference between summer and annual rankings in all States and Regions is the decreased importance of the Residential Fuel - Wood category during the summertime. The Evaporative Loss - Solvents Purchased category has the highest summertime emissions and is the top category in all Regions with respect to summer emissions. Although Residential Fuel - Wood drops substantially in ranking, it still contributes to summertime emissions in many States. (This category might drop even more in ranking if categories other than the top seven categories based on annual emissions were evaluated for the summertime rankings.) Emissions from categories such as Managed Burning - Prescribed and Agricultural Field Burning are considered to be zero for the summer months according to the NAPAP factor file.

Emissions from Cutback Asphalt Paving Operations (SCC 101) were assumed to be zero for all States in this study for the summer months. (NAPAP seasonal adjustment factors were not available in the NAPAP factor file for this category.) This assumption was based on the EPA Control Techniques Guidelines (CTG) to control emissions from the use of cutback asphalt[3] and on the EPA Reasonably Available Control Technologies (RACT) guidelines for the use of cutback asphalts.[4]

The CTG document for cutback asphalt recommends sole use of emulsified asphalt rather than cutback asphalt for paving operations. A cutback asphalt is an asphalt cement which has been liquefied by blending it with petroleum

solvents or diluents. VOC emissions occur from the cutback as the diluent evaporates from the road surface. Emulsified asphalts, which consist of asphalt cement and a water base emulsifier, generate far fewer VOC emissions than do cutback asphalts. Because true emulsified asphalt contains no VOC, substitution of emulsified asphalt for cutback asphalt would reduce VOC emissions by 100 percent. Concerns have been raised that emulsified asphalt may be unsuitable for use as a penetrating prime coat, for long term stockpiling, and for use in cold weather. However, emulsified asphalt has been used successfully in the States of New York, Pennsylvania, and Indiana during winter conditions.

In addition to the CTG recommendation and findings, the EPA requires that each State having one or more ozone nonattainment areas include RACT guidelines for the use of cutback asphalts in its State Implementation Plan (SIP). RACT, as developed by the EPA, prohibits the use of cutback asphalts whenever emulsified asphalts are reasonably available and acceptable for use. Because the EPA Regions covered in this report (Regions I, II, VI, and IX) all contain ozone nonattainment areas, the EPA requirement of RACT applies. It was assumed that the majority of asphalt paving operations would occur in the metropolitan, nonattainment areas. Furthermore, it was assumed that emulsified asphalt would be used in place of cutback asphalt and, therefore, that VOC emissions would be reduced to zero, based on information found in the CTG document for cutback asphalt.

Tables 2.3-1 through 2.3-4 compare the rankings of the top seven categories with respect to annual and summertime emissions for States within each Region. The numbers in parentheses in the Region column in each table represent another method of ranking the categories. This ranking is dependent on the ranking each category received in each State rather than on total Regional tonnage. In Region I, for example, Residential Open Burning ranks sixth, sixth, sixth, fifth, sixth, and fifth in summer emissions for Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont, respectively. The Regional ranking based on individual State rankings is then the sum of these rankings (6 + 6 + 6 + 5 + 6 + 5) divided by six (for the six States) which results in a Regional ranking of 5.7. When compared to the rankings determined by this method for the other top seven categories, Residential Open Burning's factor of 5.7 is fifth. The ranking for this category based on total tonnage is seventh. Arguments exist for both methods

for determining Regional ranking, however, discussions in this study reflect the rankings based on total tonnage.

Figures 2.3-1 through 2.3-4 are pie charts of summertime emissions for each Region. These pie charts reflect summer emissions for the top seven individual area source categories in each Region. Summer emissions for categories grouped together under the heading of All Others (as presented in Figures 2.2-1 through 2.2-4) were not estimated.

2.4 DISAGGREGATION OF SOLVENTS CATEGORY

The solvents category (Evaporative Loss - Solvents Purchased) was further disaggregated using 1985 NAPAP area source data. The State totals for the 1985 NEDS solvents category were compared to the totals of all 1985 NAPAP solvent categories added together to ensure data consistency between NEDS and NAPAP. The following NAPAP solvent categories fall under the NEDS Evaporative Loss - Solvents Purchased category and were included in this review:

- Degreasing (SCC 078)
- Dry Cleaning (SCC 079)
- Graphic Arts (SCC 080)
- Rubber and Plastics Manufacturing (SCC 081)
- Architectural Coating (SCC 082)
- Auto Body Repair (SCC 083)
- Motor Vehicle Manufacturing (SCC 084)
- Paper Coating (SCC 085)
- Fabricated Metals (SCC 086)
- Machinery Manufacturing (SCC 087)
- Furniture Manufacturing (SCC 088)
- Flat Wood Products (SCC 089)
- Other Transportation Equipment Manufacturing (SCC 090)
- Electrical Equipment Manufacturing (SCC 091)
- Ship Building and Repairing (SCC 092)
- Miscellaneous Surface Coating (SCC 093)
- Miscellaneous Solvent Use (SCC 095)

Annual emissions and seasonally adjusted emissions for these categories are discussed below. Tables 2.4-1 through 2.4-4 compare the annual and seasonal rankings of the NAPAP solvent categories among States within each Region. Table 2.4-5 compares the rankings of annual and summer emissions in the solvent categories among the four Regions.

2.4.1 Annual Results by States and Regions

Based on annual emissions totals, the Miscellaneous Solvent Use (SCC 095), Miscellaneous Surface Coating (SCC 093), and Architectural Surface Coating (SCC 082) categories consistently rank among the top categories in all Regions. The manufacturing and coating categories may show Regional variations due to the particular types of industries within the States of the Region. Categories 084 and 086 through 092 consistently rank among the bottom eight (almost half of the total number of categories) of those categories examined.

2.4.2 Seasonal Results by States and Regions

NAPAP seasonal adjustment factors were applied to annual emissions based on information from the TAM factor file. Application of NAPAP summer seasonal adjustment factors appears to cause little change in the rankings for the summer season. As with the annual emissions, categories 084 and 086 through 092 consistently rank among the bottom eight categories in summer emissions. When comparing the Regional totals between annual and summer emissions, only Region I shows any difference in the rankings. This minor difference occurs among categories 079 and 080 where annual rankings are eighth and seventh, respectively, and summer emissions are seventh and eighth, respectively.

States showing minor changes in the rankings of the area source categories include Louisiana and Oklahoma (Region VI). Several other States demonstrate slight differences in rankings from the annual rankings. These differences can be explained as being a function of two categories exhibiting the same number of tons of VOC emissions (e.g., in Connecticut, categories 084 and 091 have emissions of 71 tons VOC per year and both categories are therefore ranked in fourteenth place). Categories showing the same emission totals for a State receive the same ranking and the next position in rank is

skipped. In the above example, Connecticut has no category ranked fifteenth but instead moves from fourteenth place to sixteenth place.

Figures 2.4-1 through 2.4-4 are pie charts for each Region showing the breakdown of the solvents category.

2.4.3 Overall Conclusions

Ranking of the area source solvent categories (SCCs 078 through 095) based on annual emissions changes very little after the application of seasonal adjustment factors. The relatively insignificant changes in the annual versus summertime rankings of the area source solvent categories may indicate either that the adjustment factors do not accurately represent conditions in the summer months or that the change in conditions affects the individual categories in a similar manner, thus causing little relative change in rankings.

TABLE 2.1-1. AREA SOURCE CATEGORIES IN THE 1985 NAPAP INVENTORY

SCC	Category Description	Units
001	Residential Fuel - Anthracite Coal	lb/ton
002	Residential Fuel - Bituminous Coal	lb/ton
003	Residential Fuel - Distillate Oil	$lb/10^3$ gal
004	Residential Fuel - Residual Oil	$lb/10^3$ gal
005	Residential Fuel - Natural Gas	$lb/10^6$ ft^3
006	Residential Fuel - Wood	lb/ton
007	Commercial/Institutional Fuel - Anthracite Coal	lb/ton
008	Commercial/Institutional Fuel - Bituminous Coal	lb/ton
009	Commercial/Institutional Fuel - Distillate Oil	$lb/10^3$ gal
010	Commercial/Institutional Fuel - Residual Oil	$lb/10^3$ gal
011	Commercial/Institutional Fuel - Natural Gas	$lb/10^6$ ft^3
012	Commercial/Institutional Fuel - Wood	lb/ton
013	Industrial Fuel - Anthracite Coal	lb/ton
014	Industrial Fuel - Bituminous Coal	lb/ton
015	Industrial Fuel - Coke	lb/ton
016	Industrial Fuel - Distillate Oil	$lb/10^3$ gal
017	Industrial Fuel - Residual Oil	$lb/10^3$ gal
018	Industrial Fuel - Natural Gas	$lb/10^6$ ft^3
019	Industrial Fuel - Wood	lb/ton
020	Industrial Fuel - Process Gas	$lb/10^6$ ft^3
021	On-Site Incineration - Residential	lb/ton
022	On-Site Incineration - Industrial	lb/ton
023	On-Site Incineration - Commercial/Institutional	lb/ton
024	Open Burning - Residential	lb/ton
025	Open Burning - Industrial	lb/ton
026	Open Burning - Commercial/Institutional	lb/ton
027	Light Duty Gasoline Veh. - Limited Access Road	g/mi
028	Light Duty Gasoline Veh. - Rural Roads	g/mi
030	Light Duty Gasoline Veh. - Urban Roads	g/mi
031	Light Duty Gasoline Trucks - Limited Access Roads	g/mi
032	Light Duty Gasoline Trucks - Rural Roads	g/mi
034	Light Duty Gasoline Trucks - Urban Roads	g/mi
035	Heavy Duty Gasoline Veh. - Limited Access Roads	g/mi
036	Heavy Duty Gasoline Veh. - Rural Roads	g/mi
038	Heavy Duty Gasoline Veh. - Urban Roads	g/mi
039	Off-Highway Gasoline Vehicles	$lb/10^3$ gal
040	Heavy Duty Diesel Veh. - Limited Access Roads	g/mi
041	Heavy Duty Diesel Veh. - Rural Roads	g/mi
043	Heavy Duty Diesel Veh. - Urban Roads	g/mi
044	Off-Highway Diesel Vehicles	$lb/10^3$ gal
045	Railroad Locomotives	$lb/10^3$ gal

(continued)

TABLE 2.1-1. AREA SOURCE CATEGORIES IN THE 1985 NAPAP INVENTORY (continued)

SCC	Category Description	Units
046	Aircraft LTOs - Military	lb/LTO
047	Aircraft LTOs - Civil	lb/LTO
048	Aircraft LTOs - Commercial	lb/LTO
049	Vessels - Coal	lb/ton
050	Vessels - Diesel Oil	$lb/10^3$ gal
051	Vessels - Residual Oil	$lb/10^3$ gal
052	Vessels - Gasoline	$lb/10^3$ gal
053 *	Solvents Purchased	lb/ton
054	Gasoline Marketed	$lb/10^3$ gal
055	Unpaved Road Travel	lb/veh. mile
056	Unpaved Airstrip LTOs	lb/LTO
060	Forest Wildfires	lb/ton burned
061	Managed Burning - Prescribed	lb/ton burned
062	Agricultural Field Burning	lb/ton burned
064	Structural FIres	lb/fire
066	Light Duty Gas Vehicles (ammonia)	$lb/10^3$ gal
067	Light Duty Gas Trucks (ammonia)	$lb/10^3$ gal
068	Heavy Duty Gas Trucks (ammonia)	$lb/10^3$ gal
069	Livestock Waste Management - Turkeys	lb/animal
070	Livestock Waste Management - Sheep	lb/animal
071	Livestock Waste Management - Beef Cattle	lb/animal
072	Livestock Waste Management - Dairy Cattle	lb/animal
073	Livestock Waste Management - Swine	lb/animal
074	Livestock Waste Management - Broiler Chickens	lb/animal
075	Livestock Waste Management - Other Chickens	lb/animal
076	Anhydrous Ammonia Fertilizer Application	lb/ton
077	Beef Cattle Feedlots	lb/100 head
078	Degreasing	lb/ton used
079	Dry Cleaning	lb/ton used
080	Graphic Arts/Printing	lb/ton used
081	Rubber and Plastics Manufacturing	lb/ton used
082	Architectural Coatings	lb/ton used
083	Auto Body Repair	lb/ton used
084	Motor Vehicle Manufacture	lb/ton used
085	Paper Coating	lb/ton used
086	Fabricated Metals	lb/ton used
087	Machinery Manufacturing	lb/ton used
088	Furniture Manufacturing	lb/ton used
089	Flat Wood Products	lb/ton used
090	Other Transportation Equipment Manufacturing	lb/ton used

(continued)

TABLE 2.1-1. AREA SOURCE CATEGORIES IN THE 1985 NAPAP INVENTORY (continued)

SCC	Category Description	Units
091	Electrical Equipment Manufacturing	lb/ton used
092	Ship Building and Repair	lb/ton used
093	Miscellaneous Surface Coating	lb/ton used
094	Miscellaneous Solvent Use	lb/ton used
100	Publicly Owned Treatment Works (POTWs)	$ton/10^3$ gal
101	Cutback Asphalt Paving Operation	lb/ton asphalt
102	Fugitive Emissions from Synthetic Organic Chemical Manufacturing	**
103	Bulk Terminals and Bulk Plants	**
104	Fugitive Emissions from Petroleum Refinery Operations	**
105	Process Emissions from Bakeries	**
106	Process Emissions from Pharmaceutical Manufacturing	**
107	Process Emissions from Synthetic Fibers Manufacturing	**
108	Crude Oil and Natural Gas Production Fields	**
109	Hazardous Waste Treatment, Storage, and Disposal Facilities	**

* This category is broken down into categories 078 - 094.

** There are no emission factors for these categories. Emissions are based on national emissions estimates.

TABLE 2.2-1. TOP AREA SOURCE CATEGORIES - REGION I

STATE ------>	CONNECTICUT			MAINE		
RANKING	SOURCE CATEGORY (TONS)	% NONHWY VOC	% TOTAL AREA SOURCE VOC	SOURCE CATEGORY (TONS)	% NONHWY VOC	% TOTAL AREA SOURCE VOC
1	EVAP LOSS SOLV PURCH 82,496	54.8	38.4	FUEL COMB RES WOOD 34,099	44.2	32.8
2	FUEL COMB RES WOOD 35,517	23.6	16.6	EVAP LOSS SOLV PURCH 22,869	29.6	22.0
3	EVAP LOSS GAS MKTED 12,622	8.4	5.9	EVAP LOSS GAS MKTED 5,061	6.6	4.9
4	GAS OFF HWY VEH 6,640	4.4	3.1	VESSELS - GASOLINE 3,984	5.2	3.8
5	VESSELS - GASOLINE 3,102	2.1	1.4	GAS OFF HWY VEH 3,471	4.5	3.3
6	RES ON-SITE INCIN 3,044	2.0	1.4	RES OPEN BURNING 2,787	3.6	2.7
7	RES OPEN BURNING 2,279	1.5	1.1	RES ON-SITE INCIN 1,736	2.2	1.7
		(96.8)	(67.9)		(95.9)	(71.3)
TOTAL AREA SOURCE VOC (EXCLUDING HWY MOBILE SOURCES)	150,506	100.0	70.1	77,196	100.0	74.3
HWY MOBILE SOURCES	64,070	-	29.9	26,662	-	25.7
TOTAL STATE AREA SOURCE VOC	214,576	-	100.0	103,858	-	100.0

TABLE 2.2-1. TOP AREA SOURCE CATEGORIES - REGION I (continued)

STATE ------>	MASSACHUSETTS			NEW HAMPSHIRE		
RANKING	SOURCE CATEGORY (TONS)	% NONHWY VOC	% TOTAL AREA SOURCE VOC	SOURCE CATEGORY (TONS)	% NONHWY VOC	% TOTAL AREA SOURCE VOC
1	EVAP LOSS SOLV PURCH 148,674	55.9	40.0	EVAP LOSS SOLV PURCH 26,497	45.0	33.7
2	FUEL COMB RES WOOD 48,641	18.3	13.1	FUEL COMB RES WOOD 19,287	32.7	24.6
3	EVAP LOSS GAS MKTED 22,354	8.4	6.0	EVAP LOSS GAS MKTED 4,207	7.1	5.4
4	GAS OFF HWY VEH 10,958	4.1	3.0	GAS OFF HWY VEH 2,920	5.0	3.7
5	RES ON-SITE INCIN 9,838	3.7	2.6	RES OPEN BURNING 1,846	3.1	2.3
6	VESSELS - GASOLINE 7,994	3.0	2.2	RES ON-SITE INCIN 1,278	2.2	1.6
7	RES OPEN BURNING 5,029	1.9	1.4	CUTBACK ASPHALT 1,216	2.1	1.5
TOTAL AREA SOURCE VOC (EXCLUDING HWY MOBILE SOURCES)	265,916	(95.3) 100.0	(68.3) 71.6	58,916	(97.2) 100.0	(72.9) 75.0
HWY MOBILE SOURCES	105,431	-	28.4	19,644	-	25.0
TOTAL STATE AREA SOURCE VOC	371,347	-	100.0	78,560	-	100.0

TABLE 2.2-1. TOP AREA SOURCE CATEGORIES - REGION I (continued)

STATE ------>	RHODE ISLAND			VERMONT		
RANKING	SOURCE CATEGORY (TONS)	% NONHWY VOC	% TOTAL AREA SOURCE VOC	SOURCE CATEGORY (TONS)	% NONHWY VOC	% TOTAL AREA SOURCE VOC
1	EVAP LOSS SOLV PURCH 25,049	60.4	42.7	FUEL COMB RES WOOD 15,558	43.7	31.4
2	FUEL COMB RES WOOD 6,326	15.2	10.8	EVAP LOSS SOLV PURCH 11,466	32.2	23.1
3	EVAP LOSS GAS MKTED 3,543	8.5	6.0	EVAP LOSS GAS MKTED 2,331	6.5	4.7
4	GAS OFF HWY VEH 1,804	4.3	3.1	RES OPEN BURNING 1,730	4.9	3.5
5	RES ON-SITE INCIN 1,645	4.0	2.8	GAS OFF HWY VEH 1,525	4.3	3.1
6	VESSELS - GASOLINE 1,102	2.7	1.9	VESSELS - GASOLINE 1,200	3.4	2.4
7	RES OPEN BURNING 690	1.7	1.2	RES ON-SITE INCIN 764	2.1	1.5
TOTAL AREA SOURCE VOC		(96.8)	(68.4)		(97.0)	(69.7)
(EXCLUDING HWY MOBILE SOURCES)	41,492	100.0	70.7	35,634	100.0	71.9
HWY MOBILE SOURCES	17,217	-	29.3	13,955	-	28.1
TOTAL STATE AREA SOURCE VOC	58,709	-	100.0	49,589	-	100.0

TABLE 2.2-1. TOP AREA SOURCE CATEGORIES – REGION I (continued)

STATE ------> RANKING	SOURCE CATEGORY (TONS)	REGION I % NONHWY VOC	% TOTAL AREA SOURCE VOC
1	EVAP LOSS SOLV PURCH 317,031	50.4	36.2
2	FUEL COMB RES WOOD 159,427	25.3	18.2
3	EVAP LOSS GAS MKTED 50,117	8.0	5.7
4	GAS OFF HWY VEH 27,318	4.3	3.1
5	RES ON-SITE INCIN 18,305	2.9	2.1
6	VESSELS - GASOLINE 17,754	2.8	2.0
7	RES OPEN BURNING 14,361	2.3	1.6
TOTAL AREA SOURCE VOC (EXCLUDING HWY MOBILE SOURCES)	629,660	(96.0) 100.0	(68.9) 71.8
HWY MOBILE SOURCES	246,979	-	28.2
TOTAL STATE AREA SOURCE VOC	876,639	-	100.0

TABLE 2.2-2. TOP AREA SOURCE CATEGORIES - REGION II

STATE ------>	NEW JERSEY			NEW YORK		
RANKING	SOURCE CATEGORY (TONS)	% NONHWY VOC	% TOTAL AREA SOURCE VOC	SOURCE CATEGORY (TONS)	% NONHWY VOC	% TOTAL AREA SOURCE VOC
1	EVAP LOSS SOLV PURCH 174,178	57.4	37.9	EVAP LOSS SOLV PURCH 329,668	53.3	36.7
2	FUEL COMB RES WOOD 54,568	18.0	11.9	FUEL COMB RES WOOD 144,829	23.4	16.1
3	EVAP LOSS GAS MKTED 30,556	10.1	6.6	EVAP LOSS GAS MKTED 55,280	8.9	6.2
4	GAS OFF HWY VEH 12,141	4.0	2.6	GAS OFF HWY VEH 26,461	4.3	2.9
5	VESSELS - GASOLINE 6,736	2.2	1.5	RES OPEN BURNING 15,005	2.4	1.7
6	RES OPEN BURNING 4,544	1.5	1.0	VESSELS - GASOLINE 14,238	2.3	1.6
7	CUTBACK ASPHALT 3,834	1.3	0.8	RES ON-SITE INCIN 6,646	1.1	0.7
		(94.4)	(62.3)		(95.8)	(65.9)
TOTAL AREA SOURCE VOC (EXCLUDING HWY MOBILE SOURCES)	303,707	100.0	66.1	618,094	100.0	68.8
HWY MOBILE SOURCES	156,042	-	33.9	280,104	-	31.2
TOTAL STATE AREA SOURCE VOC	459,749	-	100.0	898,198	-	100.0

TABLE 2.2-2. TOP AREA SOURCE CATEGORIES - REGION II (continued)

STATE ------> RANKING	SOURCE CATEGORY (TONS)	REGION II % NONHWY VOC	% TOTAL AREA SOURCE VOC
1	EVAP LOSS SOLV PURCH 503,846	54.7	37.1
2	FUEL COMB RES WOOD 199,397	21.6	14.7
3	EVAP LOSS GAS MKTED 85,836	9.3	6.3
4	GAS OFF HWY VEH 38,602	4.2	2.8
5	VESSELS - GASOLINE 20,974	2.3	1.5
6	RES OPEN BURNING 19,549	2.1	1.4
7	CUTBACK ASPHALT 10,285	1.1	0.8
		(95.3)	(64.7)
TOTAL AREA SOURCE VOC (EXCLUDING HWY MOBILE SOURCES)	921,801	100.0	67.9
HWY MOBILE SOURCES	436,146	-	32.1
TOTAL STATE AREA SOURCE VOC	1,357,947	-	100.0

TABLE 2.2-3. TOP AREA SOURCE CATEGORIES - REGION VI

STATE ------>	ARKANSAS			LOUISIANA		
RANKING	SOURCE CATEGORY (TONS)	% NONHWY VOC	% TOTAL AREA SOURCE VOC	SOURCE CATEGORY (TONS)	% NONHWY VOC	% TOTAL AREA SOURCE VOC
1	EVAP LOSS SOLV PURCH 50,458	39.2	27.2	EVAP LOSS SOLV PURCH 59,476	33.2	21.4
2	FUEL COMB RES WOOD 24,644	19.1	13.3	EVAP LOSS GAS MKTED 19,951	11.1	7.2
3	VESSELS - GASOLINE 15,103	11.7	8.2	VESSELS - GASOLINE 18,184	10.2	6.5
4	EVAP LOSS GAS MKTED 10,670	8.3	5.8	FUEL COMB RES WOOD 16,578	9.3	6.0
5	DIESEL OFF HWY VEH 6,707	5.2	3.6	AGRIC BURNING 11,209	6.3	4.0
6	GAS OFF HWY VEH 5,849	4.5	3.2	GAS OFF HWY VEH 9,670	5.4	3.5
7	RES OPEN BURNING 5,553	4.3	3.0	CUTBACK ASPHALT 7,246	4.0	2.6
		(92.4)	(64.2)		(79.4)	(51.1)
TOTAL AREA SOURCE VOC (EXCLUDING HWY MOBILE SOURCES)	128,799	100.0	69.5	179,135	100.0	64.4
HWY MOBILE SOURCES	56,495	-	30.5	99,162	-	35.6
TOTAL STATE AREA SOURCE VOC	185,294	-	100.0	278,298	-	100.0

TABLE 2.2-3. TOP AREA SOURCE CATEGORIES - REGION VI (continued)

STATE ------>	NEW MEXICO			OKLAHOMA		
RANKING	SOURCE CATEGORY (TONS)	% NONHWY VOC	% TOTAL AREA SOURCE VOC	SOURCE CATEGORY (TONS)	% NONHWY VOC	% TOTAL AREA SOURCE VOC
1	FUEL COMB RES WOOD 25,184	37.9	18.2	EVAP LOSS SOLV PURCH 50,321	35.2	20.5
2	EVAP LOSS SOLV PURCH 16,239	24.5	11.8	FUEL COMB RES WOOD 38,012	26.6	15.5
3	EVAP LOSS GAS MKTED 7,143	10.8	5.2	EVAP LOSS GAS MKTED 16,765	11.7	6.8
4	FOREST MANAGED BURN 2,911	4.4	2.1	VESSELS - GASOLINE 8,669	6.1	3.5
5	GAS OFF HWY VEH 2,521	3.8	1.8	GAS OFF HWY VEH 7,249	5.1	3.0
6	CUTBACK ASPHALT 2,073	3.1	1.5	RES OPEN BURNING 4,734	3.3	1.9
7	FOREST WILDFIRES 1,895	2.9	1.4	DIESEL OFF HWY VEH 3,426	2.4	1.4
		(87.3)	(42.0)		(90.4)	(52.7)
TOTAL AREA SOURCE VOC (EXCLUDING HWY MOBILE SOURCES)	66,417	100.0	48.1	142,842	100.0	58.3
HWY MOBILE SOURCES	71,672	-	51.9	102,235	-	41.7
TOTAL STATE AREA SOURCE VOC	138,089	-	100.0	245,077	-	100.0

TABLE 2.2-3. TOP AREA SOURCE CATEGORIES - REGION VI (continued)

STATE ------>	TEXAS			REGION VI		
RANKING	SOURCE CATEGORY (TONS)	% NONHWY VOC	% TOTAL AREA SOURCE VOC	SOURCE CATEGORY (TONS)	% NONHWY VOC	% TOTAL AREA SOURCE VOC
1	EVAP LOSS SOLV PURCH 281,083	48.6	26.2	EVAP LOSS SOLV PURCH 457,577	41.8	23.8
2	EVAP LOSS GAS MKTED 81,666	14.1	7.6	EVAP LOSS GAS MKTED 136,194	12.4	7.1
3	GAS OFF HWY VEH 34,194	5.9	3.2	FUEL COMB RES WOOD 129,640	11.8	6.8
4	VESSELS - GASOLINE 32,282	5.6	3.0	VESSELS - GASOLINE 75,283	6.9	3.9
5	FUEL COMB RES WOOD 25,222	4.4	2.4	GAS OFF HWY VEH 59,483	5.4	3.1
6	CUTBACK ASPHALT 24,121	4.2	2.3	CUTBACK ASPHALT 38,171	3.5	2.0
7	RAILROAD LOCOMOTIVES 16,954	2.9	1.6	RES OPEN BURNING 32,529	3.0	1.7
		(85.6)	(46.2)		(84.8)	(48.4)
TOTAL AREA SOURCE VOC (EXCLUDING HWY MOBILE SOURCES)	578,769	100.0	54.0	1,095,966	100.0	57.1
HWY MOBILE SOURCES	493,253	-	46.0	822,817	-	42.9
TOTAL STATE AREA SOURCE VOC	1,072,022	-	100.0	1,918,783	-	100.0

TABLE 2.2-4. TOP AREA SOURCE CATEGORIES - REGION IX

STATE ------>	ARIZONA			CALIFORNIA		
RANKING	SOURCE CATEGORY (TONS)	% NONHWY VOC	% TOTAL AREA SOURCE VOC	SOURCE CATEGORY (TONS)	% NONHWY VOC	% TOTAL AREA SOURCE VOC
1	EVAP LOSS SOLV PURCH 50,901	41.1	23.9	EVAP LOSS SOLV PURCH 526,525	51.3	31.1
2	EVAP LOSS GAS MKTED 14,618	11.8	6.9	EVAP LOSS GAS MKTED 107,951	10.5	6.4
3	FUEL COMB RES WOOD 14,486	11.7	6.8	FUEL COMB RES WOOD 77,013	7.5	4.5
4	MANAGED BURNING 8,645	7.0	4.1	RES ON-SITE INCIN 59,899	5.8	3.5
5	GAS OFF HWY VEH 6,058	4.9	2.8	GAS OFF HWY VEH 54,905	5.3	3.2
6	RES ON-SITE INCIN 5,329	4.3	2.5	FOREST WILDFIRES 42,541	4.1	2.5
7	CUTBACK ASPHALT 5,280	4.3	2.5	VESSELS - GASOLINE 26,934	2.6	1.6
		(85.0)	(49.5)		(87.2)	(52.9)
TOTAL AREA SOURCE VOC (EXCLUDING HWY MOBILE SOURCES)	123,934	100.0	58.3	1,026,855	100.0	60.6
HWY MOBILE SOURCES	88,700	-	41.7	666,314	-	39.4
TOTAL STATE AREA SOURCE VOC	212,634	-	100.0	1,693,169	-	100.0

TABLE 2.2-4. TOP AREA SOURCE CATEGORIES - REGION IX (continued)

STATE ------>	NEVADA			REGION IX		
RANKING	SOURCE CATEGORY (TONS)	% NONHWY VOC	% TOTAL AREA SOURCE VOC	SOURCE CATEGORY (TONS)	% NONHWY VOC	% TOTAL AREA SOURCE VOC
1	EVAP LOSS SOLV PURCH 13,741	36.2	19.4	EVAP LOSS SOLV PURCH 591,167	49.7	29.9
2	FUEL COMB RES WOOD 6,652	17.5	9.4	EVAP LOSS GAS MKTED 127,251	10.7	6.4
3	EVAP LOSS GAS MKTED 4,682	12.3	6.6	FUEL COMB RES WOOD 98,151	8.3	5.0
4	RAILROAD LOCOMOTIVES 1,815	4.8	2.6	RES ON-SITE INCIN 66,694	5.6	3.4
5	GAS OFF HWY VEH 1,748	4.6	2.5	GAS OFF HWY VEH 62,710	5.3	3.2
6	CUTBACK ASPHALT 1,606	4.2	2.3	FOREST WILDFIRES 44,014	3.7	2.2
7	VESSELS - GASOLINE 1,481	3.9	2.1	VESSELS - GASOLINE 32,750	2.8	1.7
		(83.6)	(44.8)		(86.0)	(51.7)
TOTAL AREA SOURCE VOC (EXCLUDING HWY MOBILE SOURCES)	37,932	100.0	53.6	1,188,722	100.0	60.1
HWY MOBILE SOURCES	32,808	-	46.4	787,823	-	39.9
TOTAL STATE AREA SOURCE VOC	70,740	-	100.0	1,976,545	-	100.0

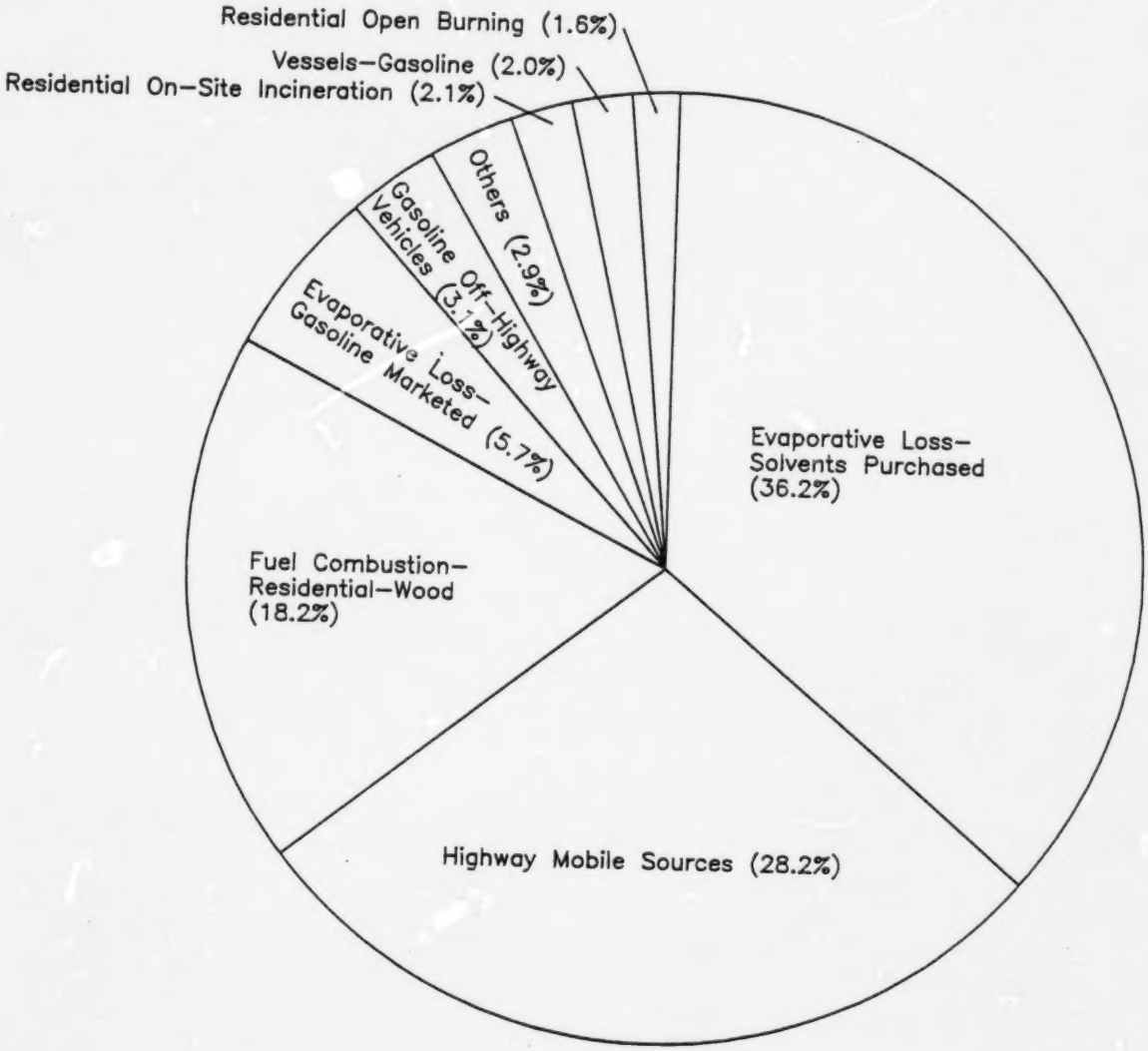

Figure 2.2-1. Percentages of area source categories - Region I.

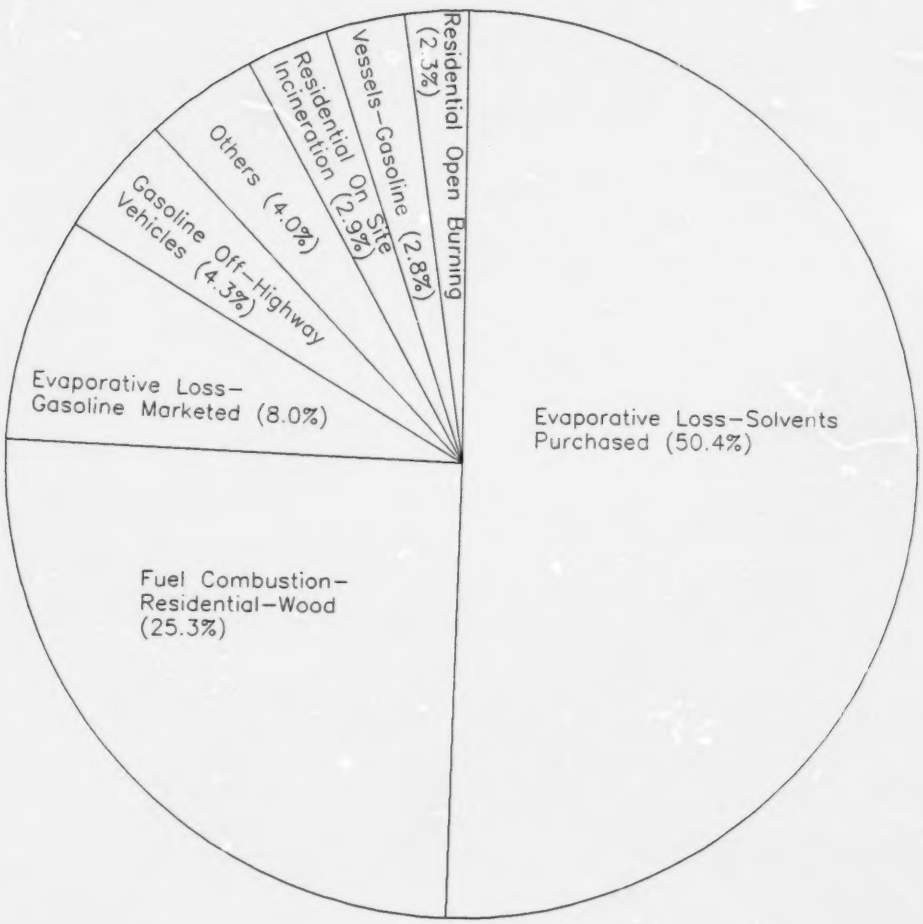

Figure 2.2-2. Percent of nonmobile area source categories - Region I.

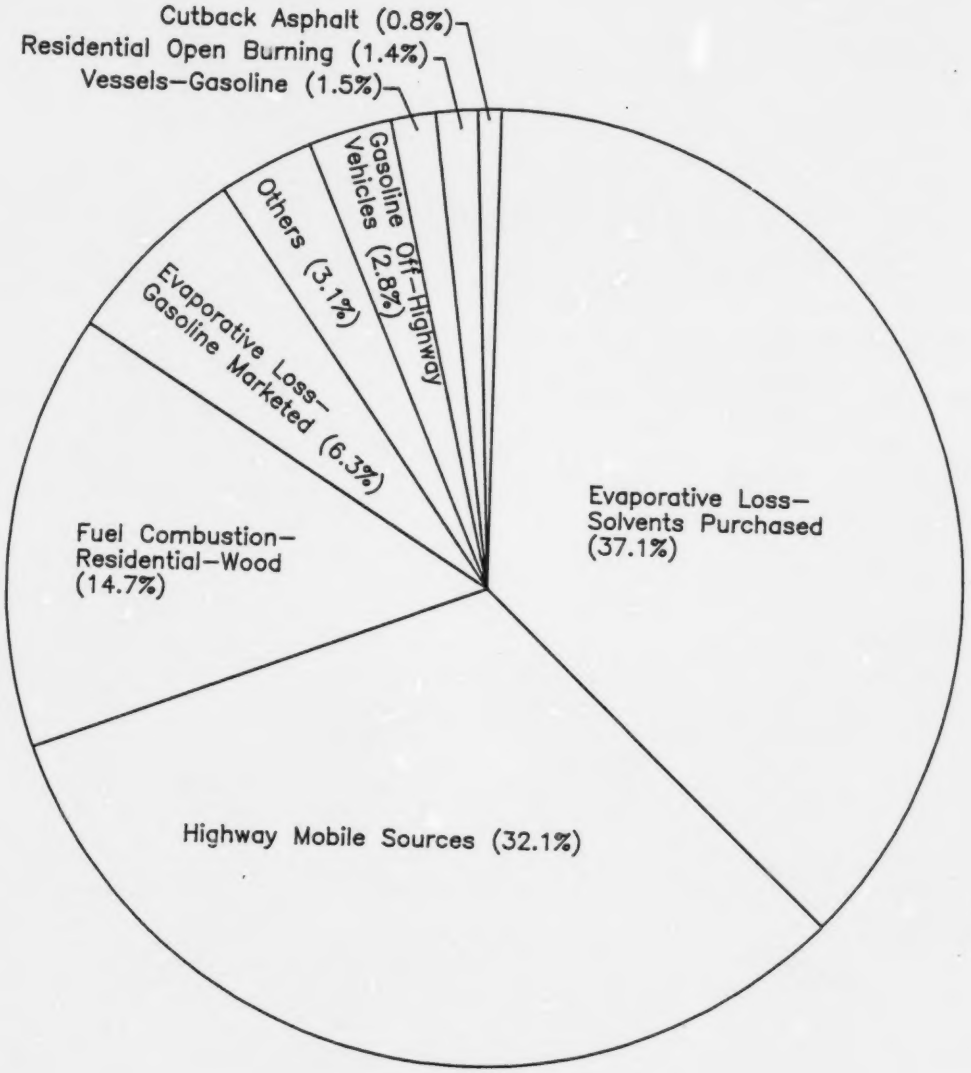

Figure 2.2-3. Percentages of area source categories - Region II

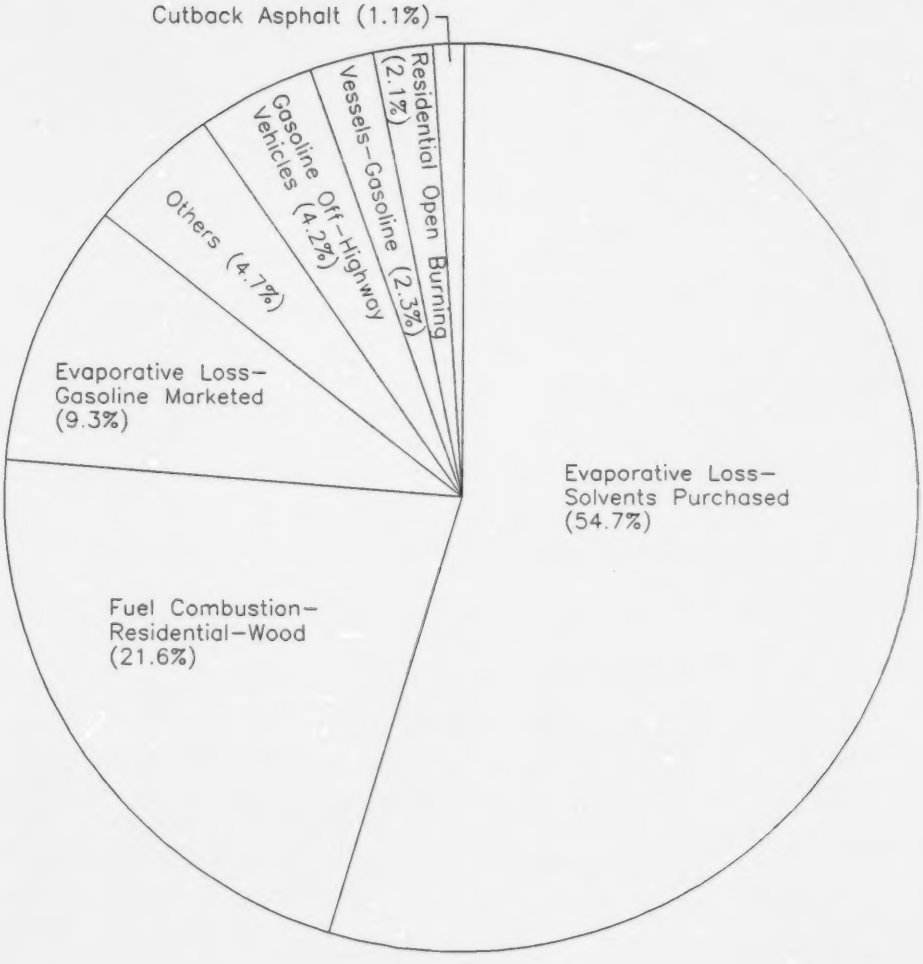

Figure 2.2-4. Percent of nonmobile area source categories - Region II.

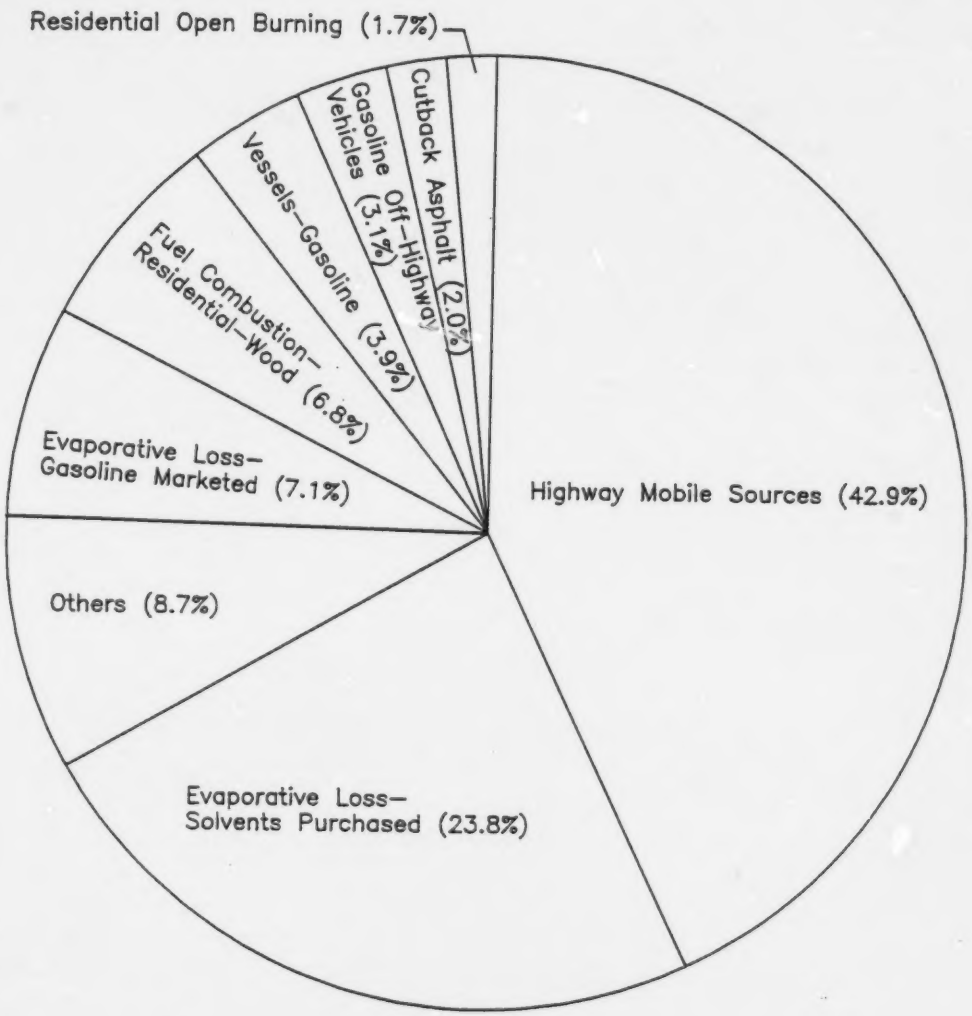

Figure 2.2-5. Percentages of area source categories - Region VI.

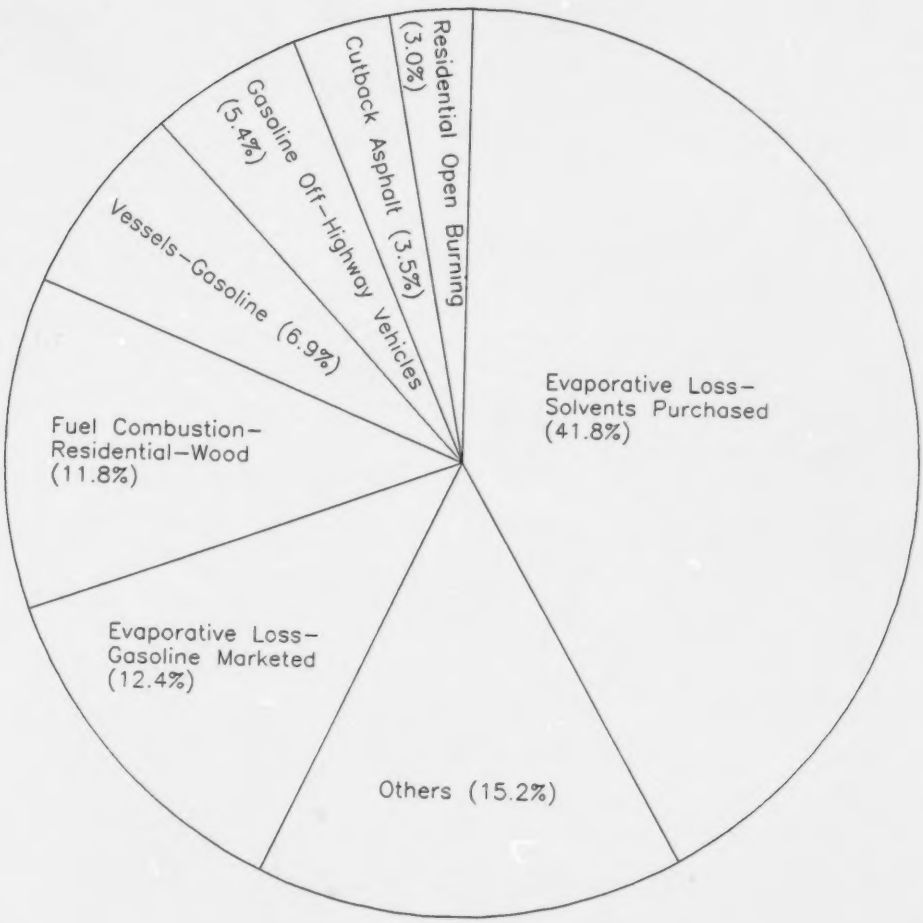

Figure 2.2-6. Percent of nonmobile area source categories - Region VI.

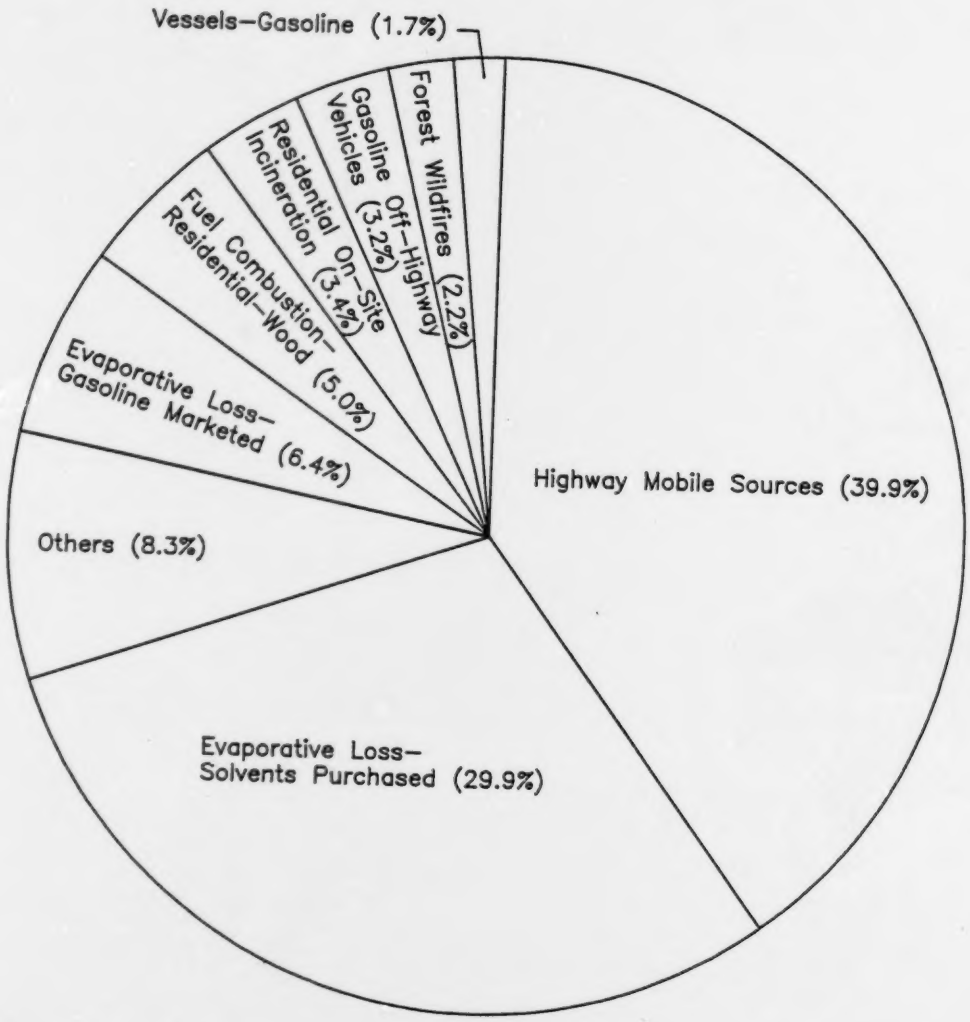

Figure 2.2–7. Percentages of area source categories – Region IX.

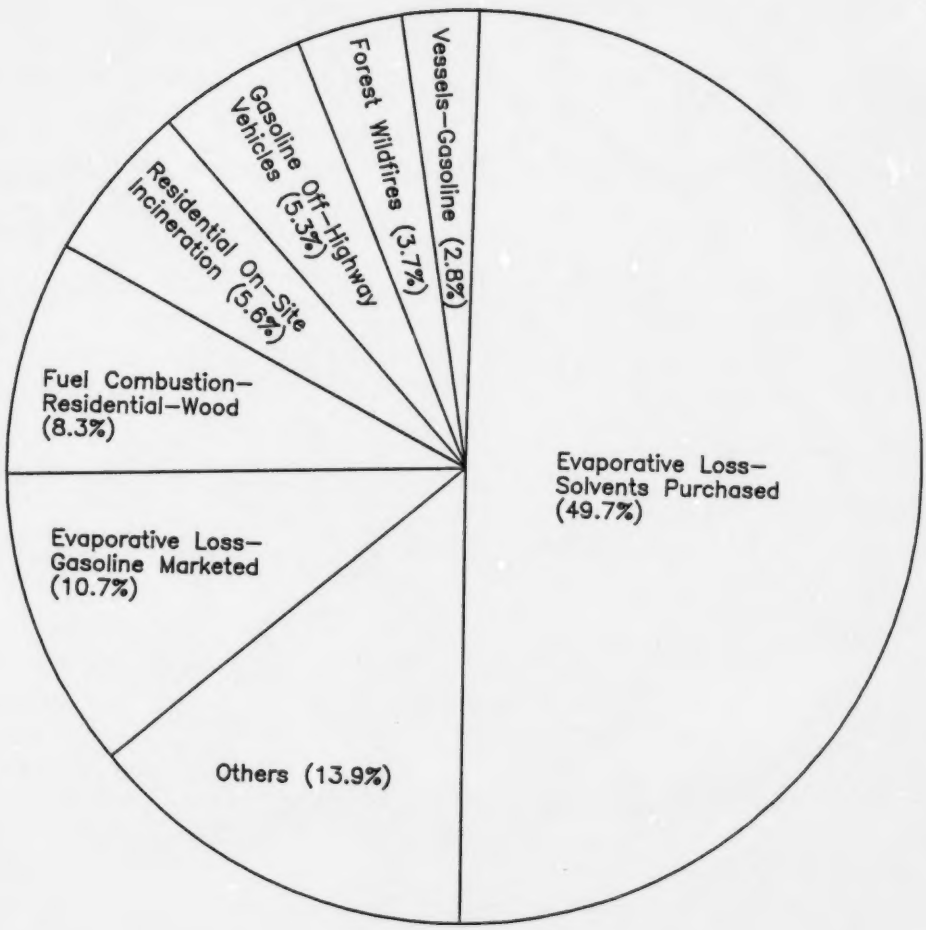

Figure 2.2-8. Percent of nonomobile area source categories - Region IX.

TABLE 2.3-1. ANNUAL AND SUMMER RANKINGS FOR AREA SOURCE CATEGORIES – REGION I

SOURCE CATEGORY	CONNECTICUT		MAINE		MASSACHUSETTS		N.HAMPSHIRE		R. ISLAND		VERMONT		REGION I		ANNUAL*	SUMMER*
	annual	summer	annual	summer	annual	summer	annual	summer	annual	summer	annual	summer	annual	summer		
EVAPORATIVE LOSS - SOLVENTS PURCHASED	1	1	2	1	1	1	1	1	1	1	2	1	1	1	(1.3)	(1.0)
FUEL COMBUSTION - RESID. - WOOD	2	7	1	4	2	7	2	4	2	7	1	6	2	6	(1.7)	(5.8)
EVAPORATIVE LOSS - GASOLINE MKTED	3	2	3	5	3	2	3	2	3	2	3	4	3	2	(3.0)	(2.8)
GASOLINE OFF-HWY VEHICLES	4	3	5	3	4	3	4	3	4	3	5	3	4	3	(4.3)	(3.0)
VESSELS - GASOLINE	5	4	4	2	6	4	8	-	6	4	6	2	6	4	(5.8)	(3.2)
RESIDENTIAL ON-SITE INCINERATION	6	5	7	7	5	5	6	6	5	5	7	7	5	5	(6.0)	(5.8)
RESIDENTIAL OPEN BURNING	7	6	6	6	7	6	5	5	7	6	4	5	7	7	(6.0)	(5.7)
CUTBACK ASPHALT PAVING OPERATIONS	8	-	8	-	8	-	7	7	8	-	9	-	8	-	(8.0)	(7.0)

* The numbers in these columns represent a ranking based on the individual rankings each category received in each state of the Region rather than on total Regional tonnage. (See page 2-4 for a more detailed explanation.)

TABLE 2.3-2. ANNUAL AND SUMMER RANKINGS FOR AREA SOURCE CATEGORIES - REGION II

SOURCE CATEGORY	NEW JERSEY annual	NEW JERSEY summer	NEW YORK annual	NEW YORK summer	REGION II annual	REGION II summer	ANNUAL*	SUMMER*
EVAPORATIVE LOSS - SOLVENTS PURCHASED	1	1	1	1	1	1	(1.0)	(1.0)
FUEL COMBUSTION - RESID. - WOOD	2	5	2	5	2	5	(2.0)	(7.0)
EVAPORATIVE LOSS - GASOLINE MKTED	3	2	3	2	3	2	(3.0)	(2.0)
GASOLINE OFF-HWY VEHICLES	4	3	4	3	4	3	(4.0)	(3.0)
VESSELS - GASOLINE	5	4	6	4	5	4	(5.5)	(4.0)
RESIDENTIAL ON-SITE INCINERATION	6	6	5	6	6	6	(5.5)	(6.0)
RESIDENTIAL OPEN BURNING	7	7	8	-	7	7	(7.5)	(7.0)
CUTBACK ASPHALT PAVING OPERATIONS	8	-	7	7	8	-	(7.5)	(7.0)

* The numbers in these columns represent a ranking based on the individual rankings each category received in each state of the Region rather than on total Regional tonnage. (See page 2-4 for a more detailed explanation.)

TABLE 2.3-3. ANNUAL AND SUMMER RANKINGS FOR AREA SOURCE CATEGORIES – REGION VI

SOURCE CATEGORY	ARKANSAS annual	ARKANSAS summer	LOUISIANA annual	LOUISIANA summer	NEW MEXICO annual	NEW MEXICO summer	OKLAHOMA annual	OKLAHOMA summer	TEXAS annual	TEXAS summer	REGION VI annual	REGION VI summer	ANNUAL*	SUMMER*
EVAPORATIVE LOSS - SOLVENTS PURCHASED	1	1	1	1	2	1	1	1	1	1	1	1	(1.2)	(1.0)
FUEL COMBUSTION - RESID. - WOOD	2	7	4	5	1	5	2	7	5	6	3	6	(2.8)	(6.0)
VESSELS - GASOLINE	3	2	3	3	11	-	4	3	4	3	4	3	(5.0)	(2.8)
EVAPORATIVE LOSS - GASOLINE MKTED	4	3	2	2	3	2	3	2	2	2	2	2	(2.8)	(2.2)
DIESEL OFF-HWY VEHICLES	5	4	12	-	10	-	7	6	8	-	8	-	(8.4)	(5.0)
GASOLINE OFF-HWY VEHICLES	6	5	6	4	5	4	5	4	3	4	5	4	(5.0)	(4.2)
RESIDENTIAL OPEN BURNING	7	6	8	-	8	-	6	5	10	-	7	5	(7.8)	(5.5)
AGRICULTURAL FIELD BURNING	N/A	-	5	5	N/A	-	N/A	-	N/A	-	14	-	(25.4)	(5.0)
CUTBACK ASPHALT PAVING OPERATIONS	8	-	7	5	6	6	8	-	6	6	6	7	(7.0)	(5.7)
FOREST MANAGED BURNING	9	-	11	-	4	6	13	-	15	-	13	-	(10.4)	(6.0)
FOREST WILDFIRES	21	-	25	-	7	3	21	-	24	-	19	-	(19.6)	(3.0)
RAILROAD LOCOMOTIVES	11	-	10	-	17	-	9	-	7	5	9	-	(10.8)	(5.0)

* The numbers in these columns represent a ranking based on the individual rankings each category received in each state of the Region rather than on total Regional tonnage. (See page 2-4 for a more detailed explanation.)

TABLE 2.3-4. ANNUAL AND SUMMER RANKINGS FOR AREA SOURCE CATEGORIES - REGION IX

SOURCE CATEGORY	ARIZONA annual	ARIZONA summer	CALIFORNIA annual	CALIFORNIA summer	NEVADA annual	NEVADA summer	REGION IX annual	REGION IX summer	ANNUAL*	SUMMER*
EVAPORATIVE LOSS - SOLVENTS PURCHASED	1	1	1	1	1	1	1	1	(1.0)	(1.0)
EVAPORATIVE LOSS - GASOLINE MKTED	2	2	2	2	3	2	2	2	(2.3)	(2.0)
FUEL COMBUSTION - RESID. - WOOD	3	5	3	7	2	6	3	7	(2.7)	(6.6)
FOREST MANAGED BURNING	4	5	9	-	12	-	8	-	(8.3)	(5.0)
GASOLINE OFF-HWY VEHICLES	5	3	5	5	5	4	5	5	(5.0)	(4.0)
RESIDENTIAL ON-SITE INCINERATION	6	4	4	4	8	-	4	4	(6.0)	(4.0)
CUTBACK ASPHALT PAVING OPERATIONS	7	5	10	-	6	7	10	-	(7.7)	(6.0)
FOREST WILDFIRES	12	-	6	3	16	-	6	3	(11.3)	(3.0)
VESSELS - GASOLINE	8	-	7	6	7	3	7	6	(7.3)	(4.5)
RAILROAD LOCOMOTIVES	10	-	12	-	4	5	12	-	(8.7)	(5.0)

* The numbers in these columns represent a ranking based on the individual rankings each category received in each state of the Region rather than on total Regional tonnage. (See page 2-4 for a more detailed explanation.)

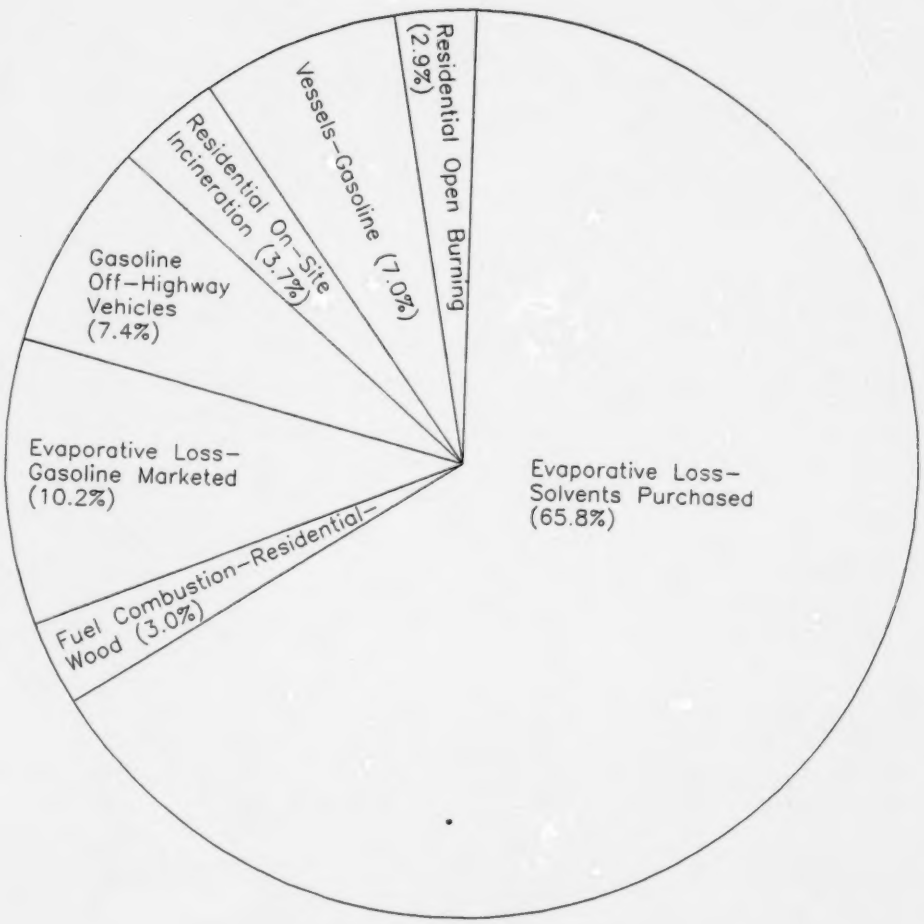

Figure 2.3-1. Percent of summer emissions for top nonmobile area source categories - Region I.

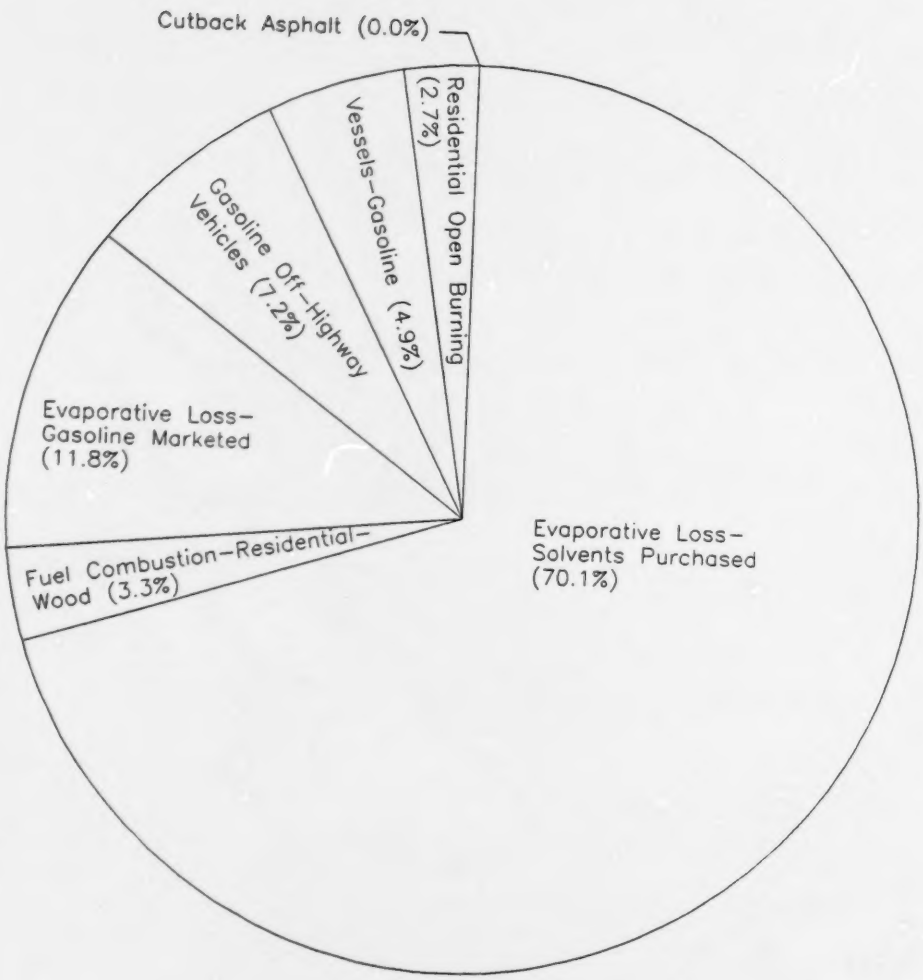

Figure 2.3-2. Percent of summer emissions for top nonmobile area source categories - Region II.

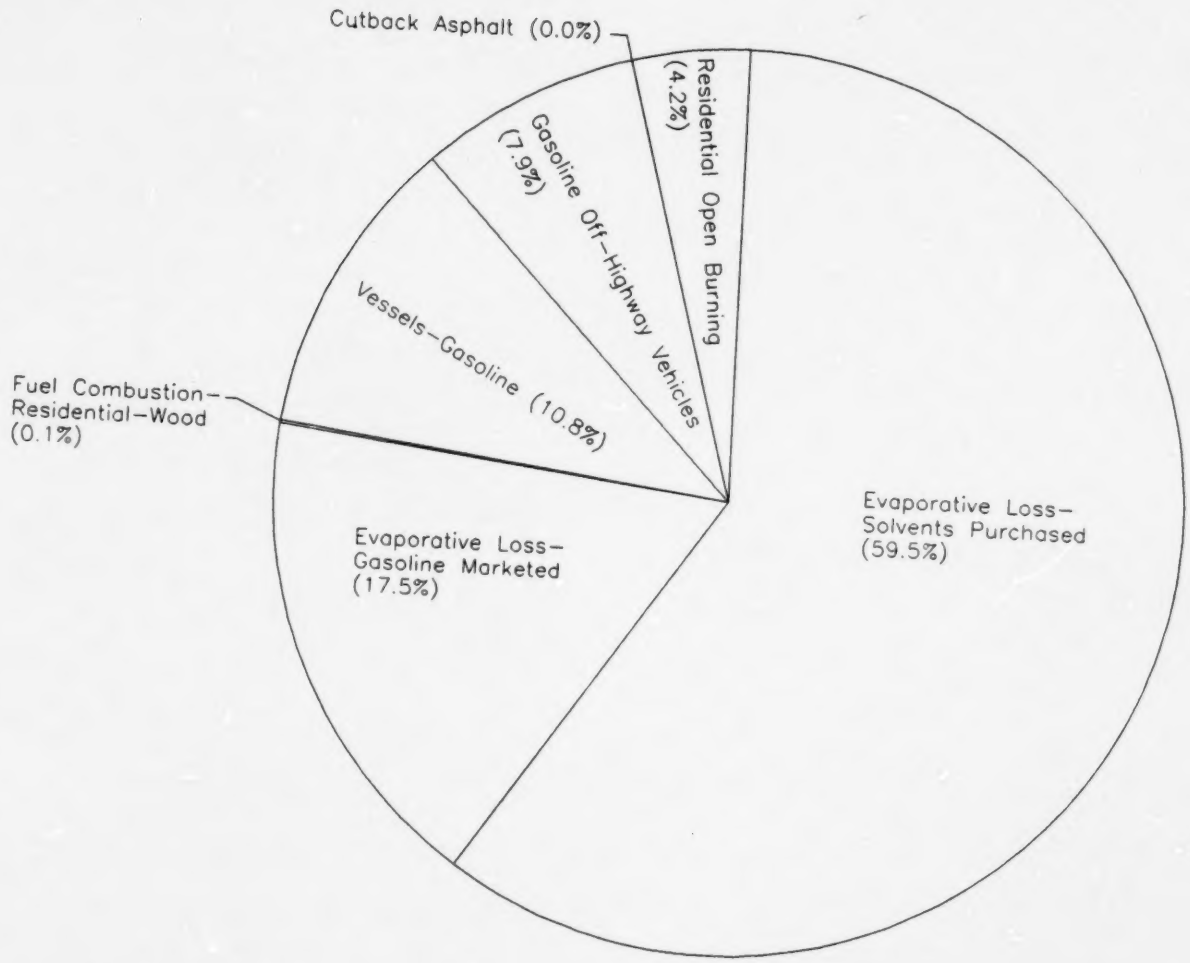

Figure 2.3-3. Percent of summer emissions for top nonmobile area source categories - Region VI.

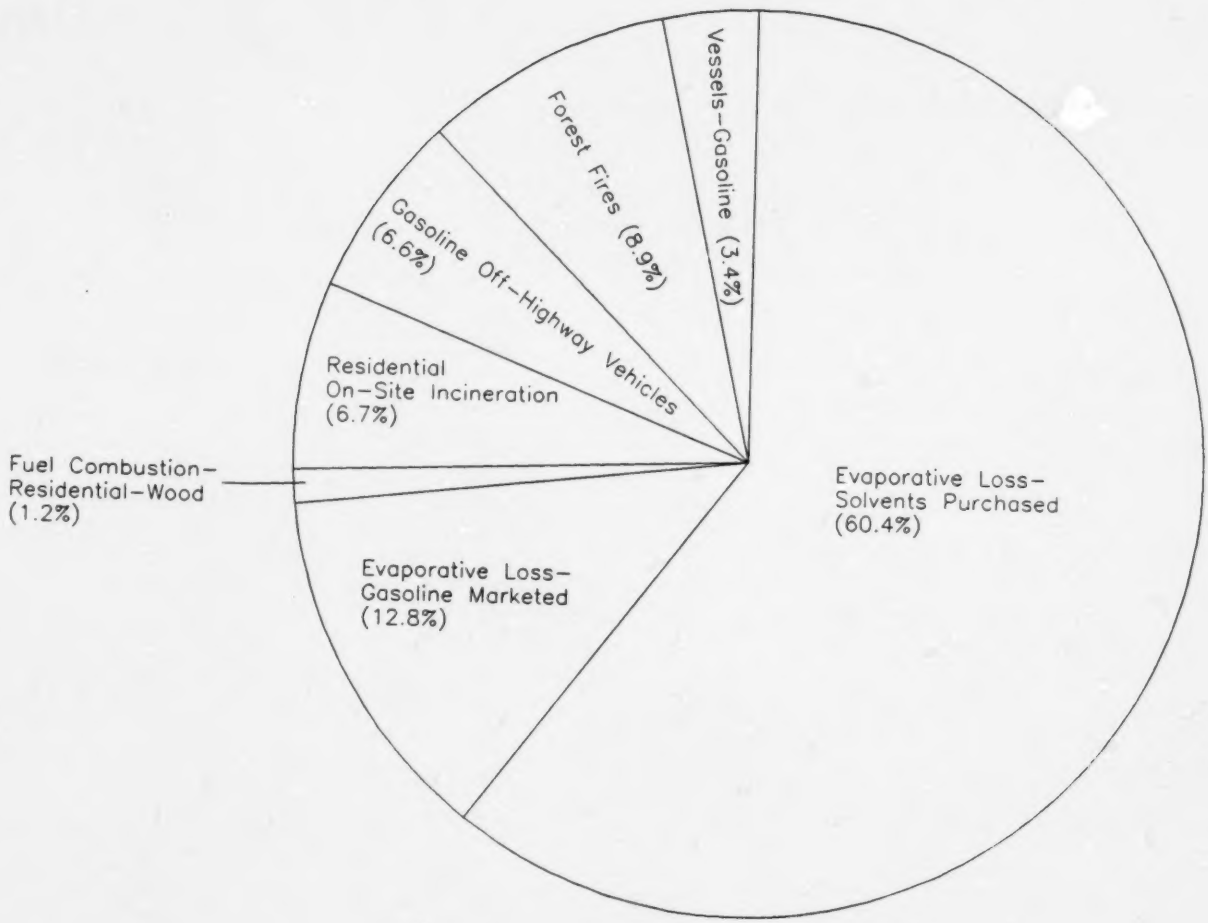

Figure 2.3-4. Percent of summer emissions for top nonmobile area source categories - Region IX.

TABLE 2.4-1. ANNUAL AND SUMMER RANKINGS FOR SOLVENT CATEGORIES - REGION I

STATE -----> / SCC/SOLVENT CATEGORY	CONNECTICUT Annual (tons)	CONNECTICUT Summer (tons)	CONNECTICUT Ranking ann	CONNECTICUT Ranking sum	MAINE Annual (tons)	MAINE Summer (tons)	MAINE Ranking ann	MAINE Ranking sum	MASSACHUSETTS Annual (tons)	MASSACHUSETTS Summer (tons)	MASSACHUSETTS Ranking ann	MASSACHUSETTS Ranking sum	NEW HAMPSHIRE Annual (tons)	NEW HAMPSHIRE Summer (tons)	NEW HAMPSHIRE Ranking ann	NEW HAMPSHIRE Ranking sum
078 DEGREASING	10,495	2,645	3	3	1,069	269	6	6	14,328	3,611	4	4	2,454	618	4	4
079 DRY CLEANING	3,906	992	7	7	856	217	8	8	6,977	1,772	8	8	948	241	9	9
080 GRAPHIC ARTS	3,216	810	8	8	812	205	9	9	7,498	1,889	7	7	1,062	268	8	8
081 RUB/PLASTICS MFG	6,832	1,756	4	4	2,128	547	5	5	16,578	4,261	3	3	4,344	1,116	1	1
082 ARCHITECTURAL CTG	6,102	1,550	5	5	2,238	568	4	4	11,197	2,844	6	6	1,920	488	5	5
083 AUTO BODY REPAIR	2,056	522	10	10	1,048	266	7	7	4,297	1,091	9	9	1,135	288	7	7
084 MOTOR VEHICLE MFG	272	71	15	14	17	4	16	16	109	28	16	16	56	15	16	16
085 PAPER COATING	4,136	1,038	6	6	2,405	604	3	3	12,467	3,129	5	5	1,853	465	6	6
086 FABRICATED METALS	2,217	559	9	9	133	34	12	12	2,611	658	10	10	325	82	12	12
087 MACHINERY MFG	964	240	11	11	104	26	13	13	1,877	467	11	11	404	101	10	10
088 FURNITURE MFG	923	234	12	12	201	51	11	11	1,698	430	12	12	332	84	11	11
089 FLAT WOOD PRODUCTS	133	34	17	17	78	20	14	14	223	58	15	14	103	27	15	14
090 OTHER TRANS EQUIP	241	63	16	16	9	2	17	17	56	15	17	17	6	2	17	17
091 ELECTR EQUIP MFG	281	71	14	14	32	8	15	15	509	128	13	13	109	27	14	14
092 SHIP BUILD/REPAIR	490	123	13	13	357	90	10	10	231	58	14	14	112	28	13	13
093 MISC SURFACE CTG	13,241	3,363	2	2	2,923	742	2	2	20,973	5,327	2	2	3,473	882	3	3
095 MISC SOLVENT USE	26,991	6,802	1	1	8,459	2,131	1	1	47,045	11,855	1	1	7,973	2,009	1	1
TOTAL	82,496	20,873			22,869	5,784			148,674	37,621			26,609	6,741		

TABLE 2.4-1. ANNUAL AND SUMMER RANKINGS FOR SOLVENT CATEGORIES - REGION I (continued)

STATE -----> SCC/SOLVENT CATEGORY	RHODE ISLAND Annual (tons)	Summer	Ranking ann	sum	VERMONT Annual (tons)	Summer	Ranking ann	sum	REGION I Annual (tons)	Summer	Ranking ann	sum
078 DEGREASING	3,098	781	3	3	1,054	266	3	3	32,498	8,190	4	4
079 DRY CLEANING	927	235	8	8	381	97	9	9	13,995	3,554	8	7
080 GRAPHIC ARTS	854	215	9	9	573	144	7	7	14,015	3,531	7	8
081 RUB/PLASTICS MFG	2,809	722	4	4	968	249	5	5	33,659	8,651	3	3
082 ARCHITECTURAL CTG	1,861	473	5	5	1,028	261	4	4	24,346	6,184	5	5
083 AUTO BODY REPAIR	656	167	10	10	456	116	8	8	9,648	2,450	9	9
084 MOTOR VEHICLE MFG	79	21	13	13	20	5	16	16	553	144	16	16
085 PAPER COATING	1,148	288	6	6	840	211	6	6	22,849	5,735	6	6
086 FABRICATED METALS	957	241	7	7	263	66	10	10	6,506	1,640	10	10
087 MACHINERY MFG	171	43	12	12	144	36	12	12	3,664	913	12	12
088 FURNITURE MFG	328	83	11	11	220	56	11	11	3,702	938	11	11
089 FLAT WOOD PRODUCTS	49	13	15	15	45	12	15	15	631	164	15	15
090 OTHER TRANS EQUIP	1	0	17	17	9	2	17	17	322	84	17	17
091 ELECTR EQUIP MFG	60	15	14	14	53	13	13	13	1,044	262	14	14
092 SHIP BUILD/REPAIR	2	1	16	16	53	13	13	13	1,245	313	13	13
093 MISC SURFACE CTG	3,847	977	2	2	1,446	367	2	2	45,903	11,658	2	2
095 MISC SOLVENT USE	8,092	2,039	1	1	3,964	999	1	1	102,524	25,835	1	1
TOTAL	24,939	6,314			11,517	2,913			317,104	80,246		

TABLE 2.4-2. ANNUAL AND SUMMER RANKINGS FOR SOLVENT CATEGORIES - REGION II

STATE------> SCC/SOLVENT CATEGORY	NEW JERSEY Annual (tons)	NEW JERSEY Summer (tons)	NEW JERSEY Ranking ann	NEW JERSEY Ranking sum	NEW YORK Annual (tons)	NEW YORK Summer (tons)	NEW YORK Ranking ann	NEW YORK Ranking sum	REGION II Annual (tons)	REGION II Summer (tons)	REGION II Ranking ann	REGION II Ranking sum
078 DEGREASING	11,158	2,812	6	6	24,388	6,146	4	4	35,546	8,958	5	5
079 DRY CLEANING	8,254	2,097	8	8	16,809	4,269	8	8	25,063	6,366	8	8
080 GRAPHIC ARTS	8,793	2,216	7	7	21,924	5,525	5	5	30,717	7,741	6	6
081 RUB/PLASTICS MFG	21,804	5,604	3	3	18,050	4,639	6	6	39,854	10,243	4	4
082 ARCHITECTURAL CTG	14,547	3,695	4	4	34,197	8,686	3	3	48,744	12,381	3	3
083 AUTO BODY REPAIR	6,947	1,765	9	9	10,427	2,648	9	9	17,374	4,413	9	9
084 MOTOR VEHICLE MFG	398	104	14	14	1,283	335	13	13	1,681	439	13	13
085 PAPER COATING	12,630	3,170	5	5	17,087	4,289	7	7	29,717	7,459	7	7
086 FABRICATED METALS	2,479	625	11	11	3,868	975	11	11	6,347	1,600	11	11
087 MACHINERY MFG	1,357	338	12	12	2,860	712	12	12	4,217	1,050	12	12
088 FURNITURE MFG	2,800	708	10	10	5,300	1,341	10	10	8,100	2,049	10	10
089 FLAT WOOD PRODUCTS	272	70	15	15	555	143	15	15	827	213	15	15
090 OTHER TRANS EQUIP	23	6	17	17	128	33	16	16	151	39	17	17
091 ELECTR EQUIP MFG	456	115	13	13	930	234	14	14	1,386	349	14	14
092 SHIP BUILD/REPAIR	163	41	16	16	112	28	17	17	275	69	16	16
093 MISC SURFACE CTG	23,689	6,017	2	2	43,401	11,024	2	2	67,090	17,041	2	2
095 MISC SOLVENT USE	58,459	14,732	1	1	128,298	32,331	1	1	186,757	47,063	1	1
TOTAL	174,229	44,115			329,617	83,358			503,846	127,473		

TABLE 2.4-3. ANNUAL AND SUMMER RANKINGS FOR SOLVENT CATEGORIES - REGION VI

STATE------> SCC/SOLVENT CATEGORY	ARKANSAS Annual (tons)	Summer	Ranking ann	sum	LOUISIANA Annual (tons)	Summer	Ranking ann	sum	NEW MEXICO Annual (tons)	Summer	Ranking ann	sum	OKLAHOMA Annual (tons)	Summer	Ranking ann	sum
078 DEGREASING	2,666	672	6	6	2,554	644	7	7	584	147	6	6	3,686	929	5	5
079 DRY CLEANING	2,509	637	7	7	4,172	1,060	4	4	1,248	317	3	3	3,881	986	4	4
080 GRAPHIC ARTS	1,801	454	9	9	1,488	375	8	8	446	112	7	7	1,460	368	8	8
081 RUB/PLASTICS MFG	5,045	1,297	4	4	1,216	313	9	9	89	23	10	9	1,998	513	7	7
082 ARCHITECTURAL CTG	4,539	1,153	5	5	8,612	2,187	2	2	2,790	709	2	2	6,346	1,612	2	2
083 AUTO BODY REPAIR	1,175	298	10	10	2,915	740	6	6	960	244	5	5	2,486	631	6	6
084 MOTOR VEHICLE MFG	231	60	14	14	68	18	15	15	69	18	13	12	403	105	13	12
085 PAPER COATING	5,199	1,305	3	3	4,164	1,045	5	5	90	23	9	9	1,333	335	9	9
086 FABRICATED METALS	752	190	11	11	629	159	10	10	61	15	14	14	867	218	10	10
087 MACHINERY MFG	335	83	12	12	189	47	12	13	72	18	12	12	408	102	12	13
088 FURNITURE MFG	2,040	516	8	8	174	44	14	14	100	25	8	8	447	113	11	11
089 FLAT WOOD PRODUCTS	296	76	13	13	188	49	13	12	76	20	11	11	122	31	14	14
090 OTHER TRANS EQUIP	14	4	17	17	32	8	17	17	9	2	16	16	41	11	16	16
091 ELECTR EQUIP MFG	112	28	15	15	53	13	16	16	24	6	15	15	74	19	15	15
092 SHIP BUILD/REPAIR	58	15	16	16	529	133	11	11	-	-	17	17	5	1	17	17
093 MISC SURFACE CTG	6,279	1,595	2	2	4,771	1,212	3	3	1,033	262	4	4	5,133	1,304	3	3
095 MISC SOLVENT USE	17,407	4,387	1	1	27,722	6,986	1	1	8,588	2,164	1	1	21,631	5,451	1	1
TOTAL	50,458	12,770			59,476	15,033			16,239	4,105			50,321	12,729		

TABLE 2.4-3. ANNUAL AND SUMMER RANKINGS FOR SOLVENT CATEGORIES - REGION VI (continued)

STATE------> SCC/SOLVENT CATEGORY	TEXAS Annual (tons)	TEXAS Summer (tons)	TEXAS Ranking ann	TEXAS Ranking sum	REGION VI Annual (tons)	REGION VI Summer (tons)	REGION VI Ranking ann	REGION VI Ranking sum
078 DEGREASING	17,394	4,383	6	6	26,884	6,775	6	6
079 DRY CLEANING	24,208	6,149	4	4	36,018	9,149	4	4
080 GRAPHIC ARTS	9,180	2,313	8	8	14,375	3,622	9	9
081 RUB/PLASTICS MFG	16,699	4,292	7	7	25,047	6,438	7	7
082 ARCHITECTURAL CTG	31,477	7,995	2	2	53,764	13,656	2	2
083 AUTO BODY REPAIR	19,872	5,047	5	5	27,408	6,960	5	5
084 MOTOR VEHICLE MFG	1,033	270	14	14	1,804	471	14	14
085 PAPER COATING	8,628	2,166	9	9	19,414	4,874	8	8
086 FABRICATED METALS	4,359	1,098	10	10	6,668	1,680	11	11
087 MACHINERY MFG	2,227	555	12	12	3,231	805	12	12
088 FURNITURE MFG	4,007	1,014	11	11	6,768	1,712	10	10
089 FLAT WOOD PRODUCTS	1,497	386	13	13	2,179	562	13	13
090 OTHER TRANS EQUIP	203	53	17	17	299	78	17	17
091 ELECTR EQUIP MFG	586	148	15	15	849	214	15	15
092 SHIP BUILD/REPAIR	250	63	16	16	842	212	16	16
093 MISC SURFACE CTG	29,322	7,448	3	3	46,538	11,821	3	3
095 MISC SOLVENT USE	110,141	27,756	1	1	185,489	46,744	1	1
TOTAL	281,083	71,136			457,577	115,773		

TABLE 2.4-4. ANNUAL AND SUMMER RANKINGS FOR SOLVENT CATEGORIES - REGION IX

STATE------> SCC/SOLVENT CATEGORY	ARIZONA Annual (tons)	ARIZONA Summer (tons)	Ranking ann	Ranking sum	CALIFORNIA Annual (tons)	CALIFORNIA Summer (tons)	Ranking ann	Ranking sum	NEVADA Annual (tons)	NEVADA Summer (tons)	Ranking ann	Ranking sum	REGION IX Annual (tons)	REGION IX Summer (tons)	Ranking sum	Ranking sum
078 DEGREASING	4,375	1,103	4	4	45,250	11,403	5	5	386	97	7	7	50,011	12,603	5	5
079 DRY CLEANING	3,028	769	6	6	23,793	6,043	7	7	1,317	335	4	4	28,138	7,147	7	7
080 GRAPHIC ARTS	1,474	371	8	8	18,202	4,587	8	8	376	95	8	8	20,052	5,053	8	8
081 RUB/PLASTICS MFG	2,231	573	7	7	38,819	9,976	6	6	634	163	6	6	41,684	10,712	6	6
082 ARCHITECTURAL CTG	6,129	1,557	2	2	50,703	12,879	3	3	1,799	457	3	3	58,631	14,893	3	3
083 AUTO BODY REPAIR	4,120	1,046	5	5	49,348	12,534	4	4	2,710	688	2	2	56,178	14,268	4	4
084 MOTOR VEHICLE MFG	32	8	16	16	1,980	517	13	13	18	5	14	14	2,030	530	14	14
085 PAPER COATING	833	209	9	9	17,551	4,405	9	9	82	21	9	9	18,466	4,635	9	9
086 FABRICATED METALS	422	106	12	12	6,921	1,744	11	11	60	15	11	11	7,403	1,865	11	11
087 MACHINERY MFG	633	158	10	10	5,662	1,410	12	12	35	9	13	12	6,330	1,577	12	12
088 FURNITURE MFG	618	156	11	11	12,398	3,137	10	10	66	17	10	10	13,082	3,310	10	10
089 FLAT WOOD PRODUCTS	253	65	13	13	1,733	447	15	15	36	9	12	12	2,022	521	15	15
090 OTHER TRANS EQUIP	101	26	15	15	914	238	16	16	4	1	16	16	1,019	265	16	16
091 ELECTR EQUIP MFG	253	64	14	14	1,942	489	14	14	9	2	15	15	2,204	555	13	13
092 SHIP BUILD/REPAIR	18	5	17	17	444	112	17	17	-	-	17	17	462	117	17	17
093 MISC SURFACE CTG	5,265	1,337	3	3	62,233	15,807	2	2	666	169	5	5	68,164	17,313	2	2
095 MISC SOLVENT USE	21,116	5,321	1	1	188,632	47,535	1	1	5,543	1,397	1	1	215,291	54,253	1	1
TOTAL	50,901	12,874			526,525	133,263			13,741	3,480			591,167	149,617		

TABLE 2.4-5. REGIONAL RANKINGS OF ANNUAL AND SUMMER EMISSIONS IN SOLVENT CATEGORIES

NAPAP CATEGORIES (SCC)	REGION I		REGION II		REGION VI		REGION IX	
	Annual	Summer	Annual	Summer	Annual	Summer	Annual	Summer
078	4	4	5	5	6	6	5	5
079	7	8	8	8	4	4	7	7
080	8	7	6	6	9	9	8	8
081	3	3	4	4	7	7	6	6
082	5	5	3	3	2	2	3	3
083	9	9	9	9	5	5	4	4
084	16	16	13	13	14	14	14	14
085	6	6	7	7	8	8	9	9
086	10	10	11	11	11	11	11	11
087	12	12	12	12	12	12	12	12
088	11	11	10	10	10	10	10	10
089	15	15	15	15	13	13	15	15
090	17	17	17	17	17	17	16	16
091	14	14	14	14	15	15	13	13
092	13	13	16	16	16	16	17	17
093	2	2	2	2	3	3	2	2
095	1	1	1	1	1	1	1	1

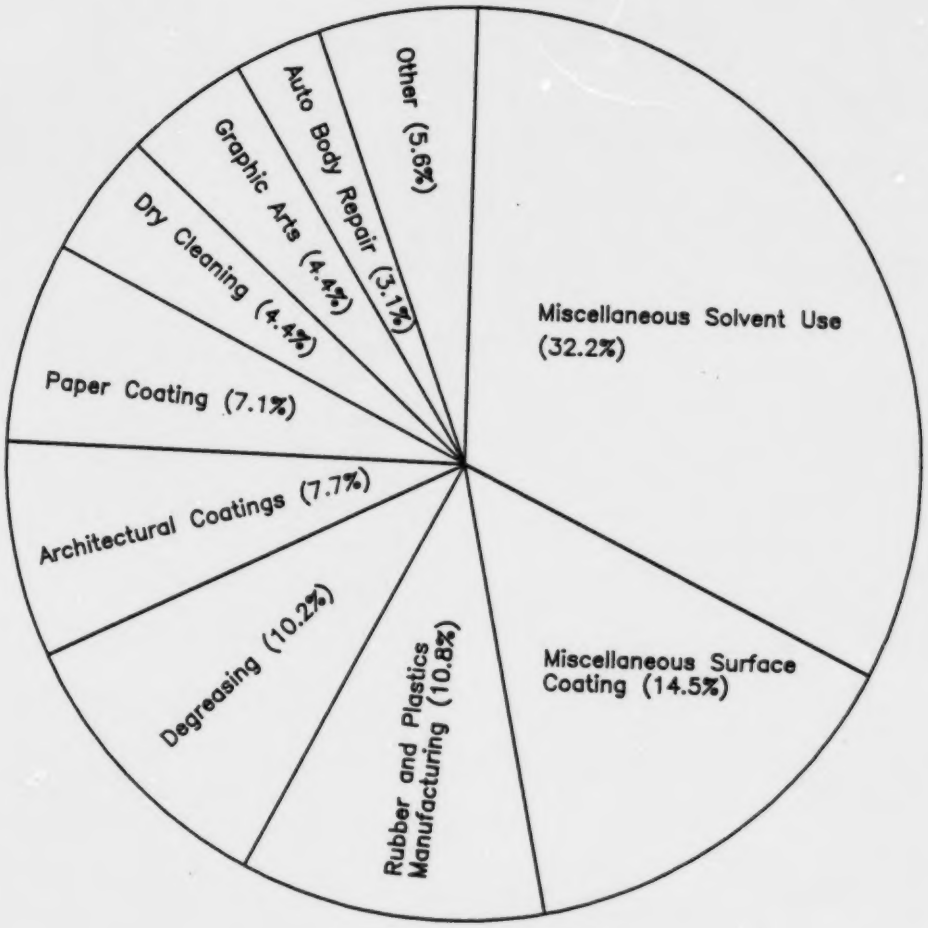

Figure 2.4-1. Solvent category emissions - Region I.

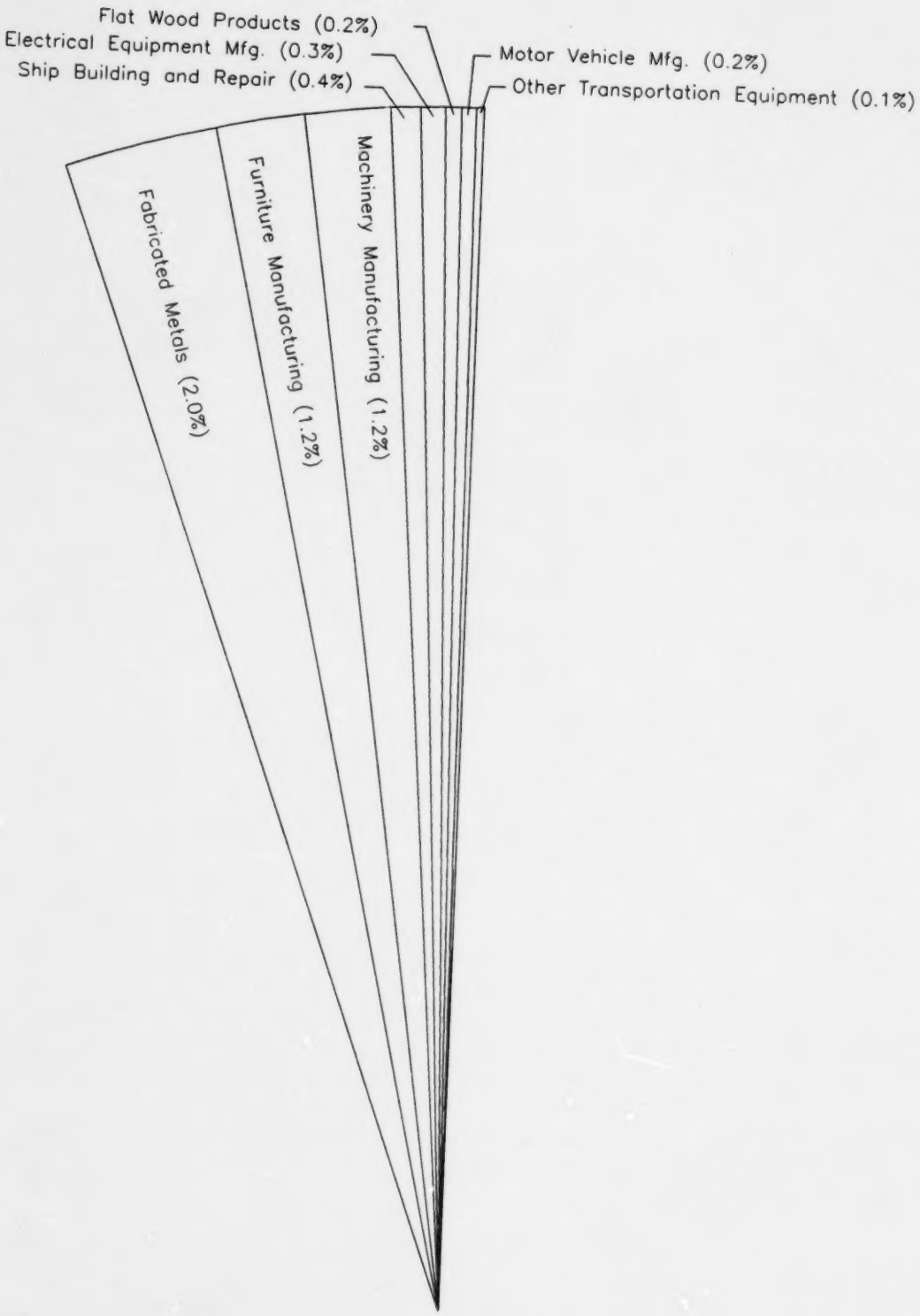

Figure 2.4-1. Solvent category emissions - Region I. (continued)

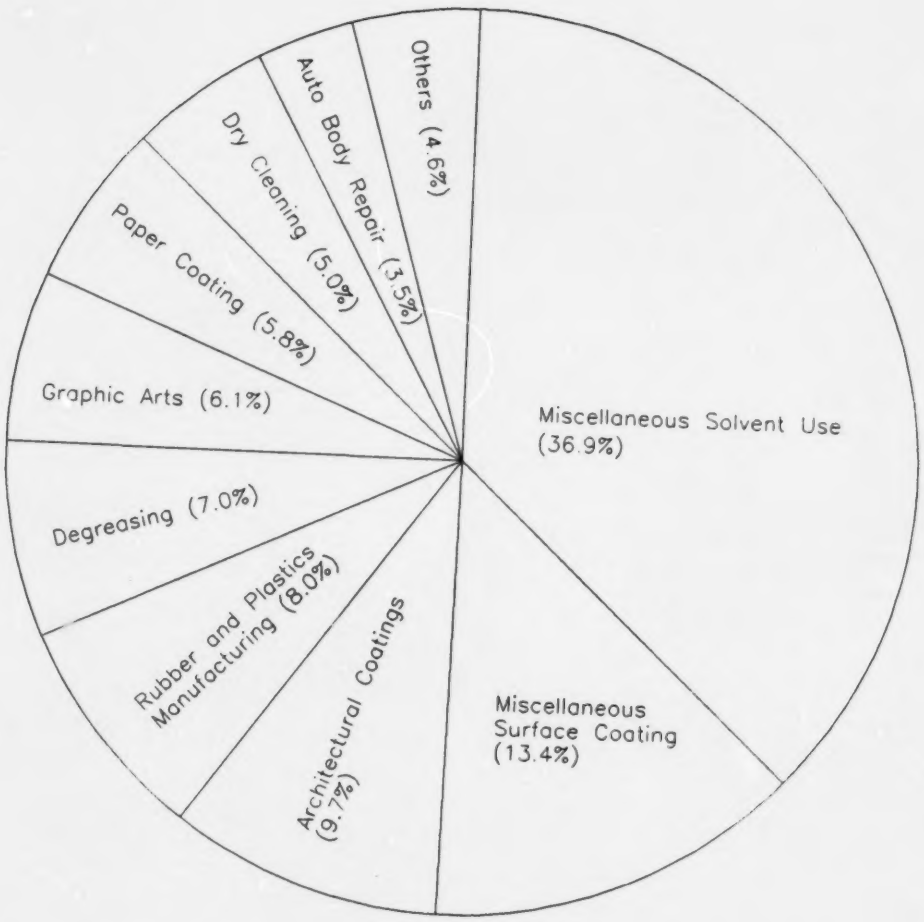

Figure 2.4-2. Solvent category emissions - Region II.

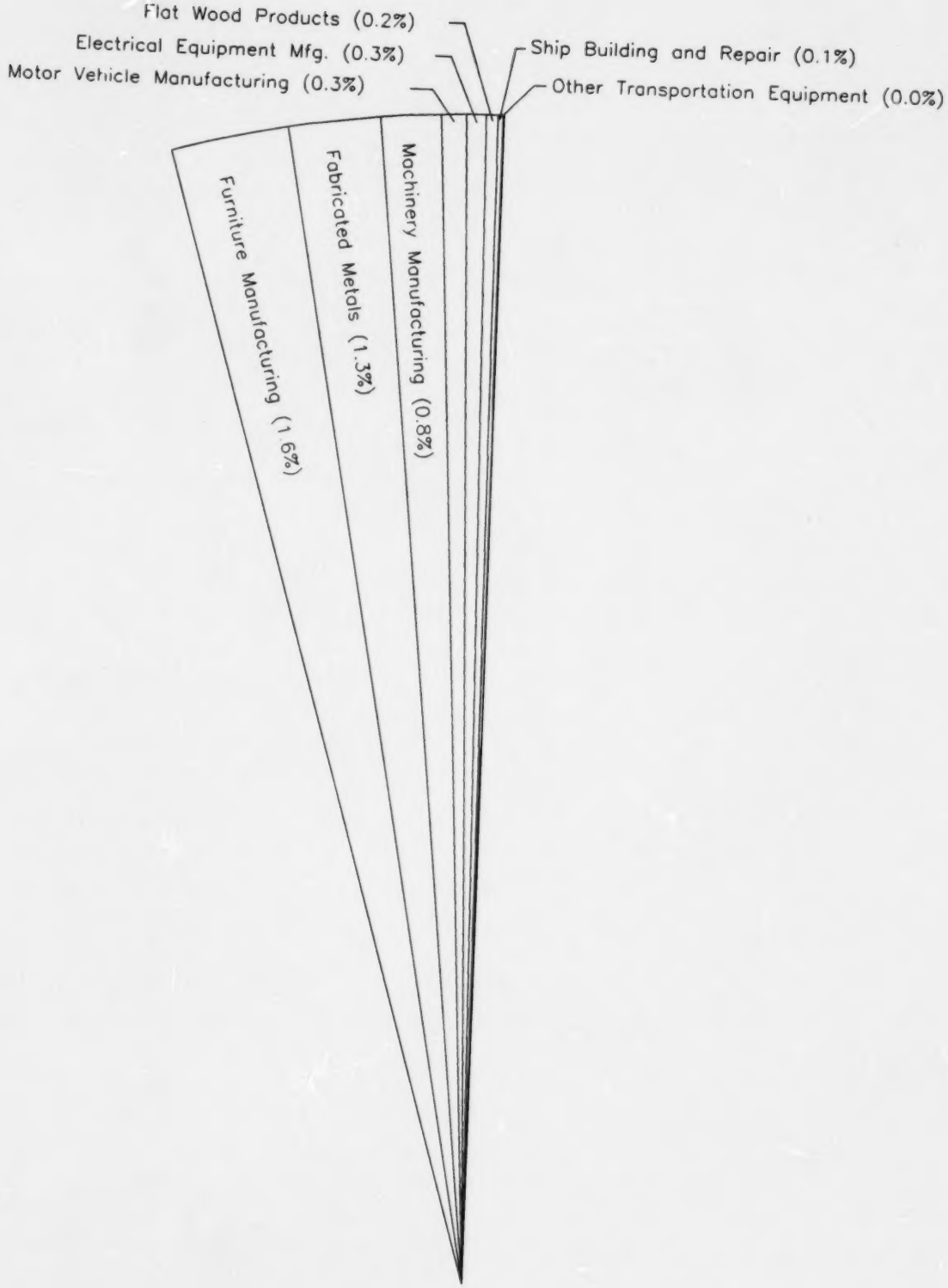

Figure 2.4-2. Solvent category emissions - Region II. (continued)

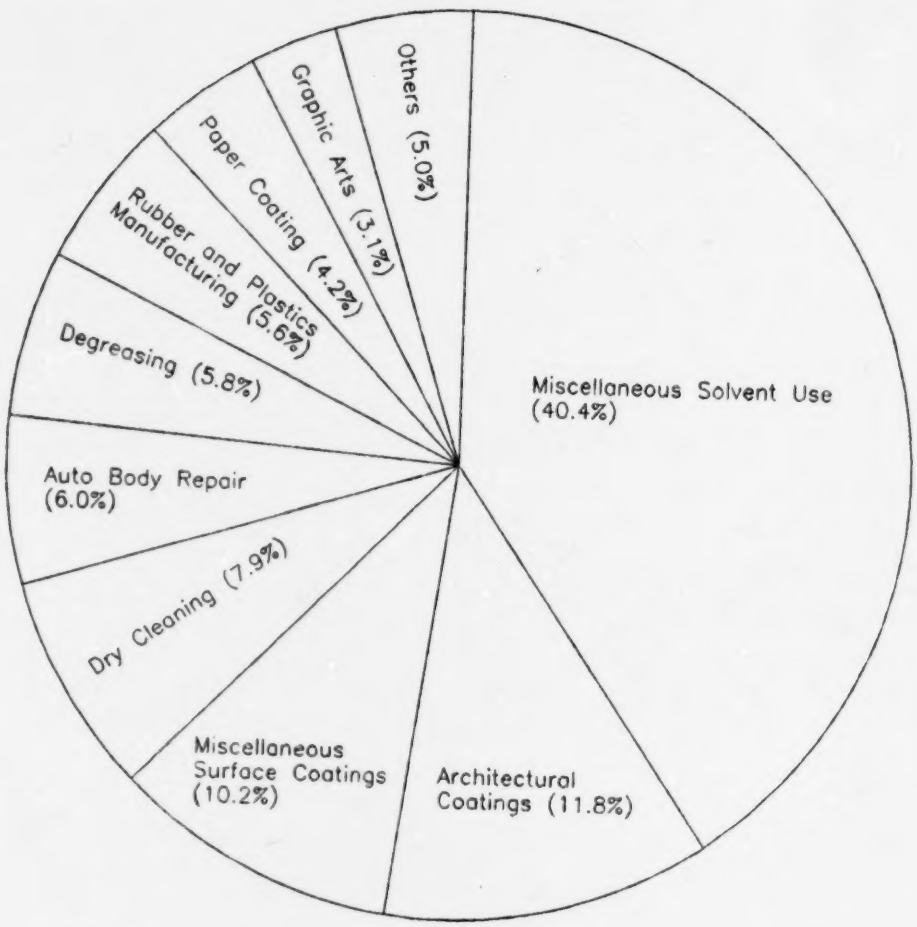

Figure 2.4-3. Solvent category emissions - Region VI.

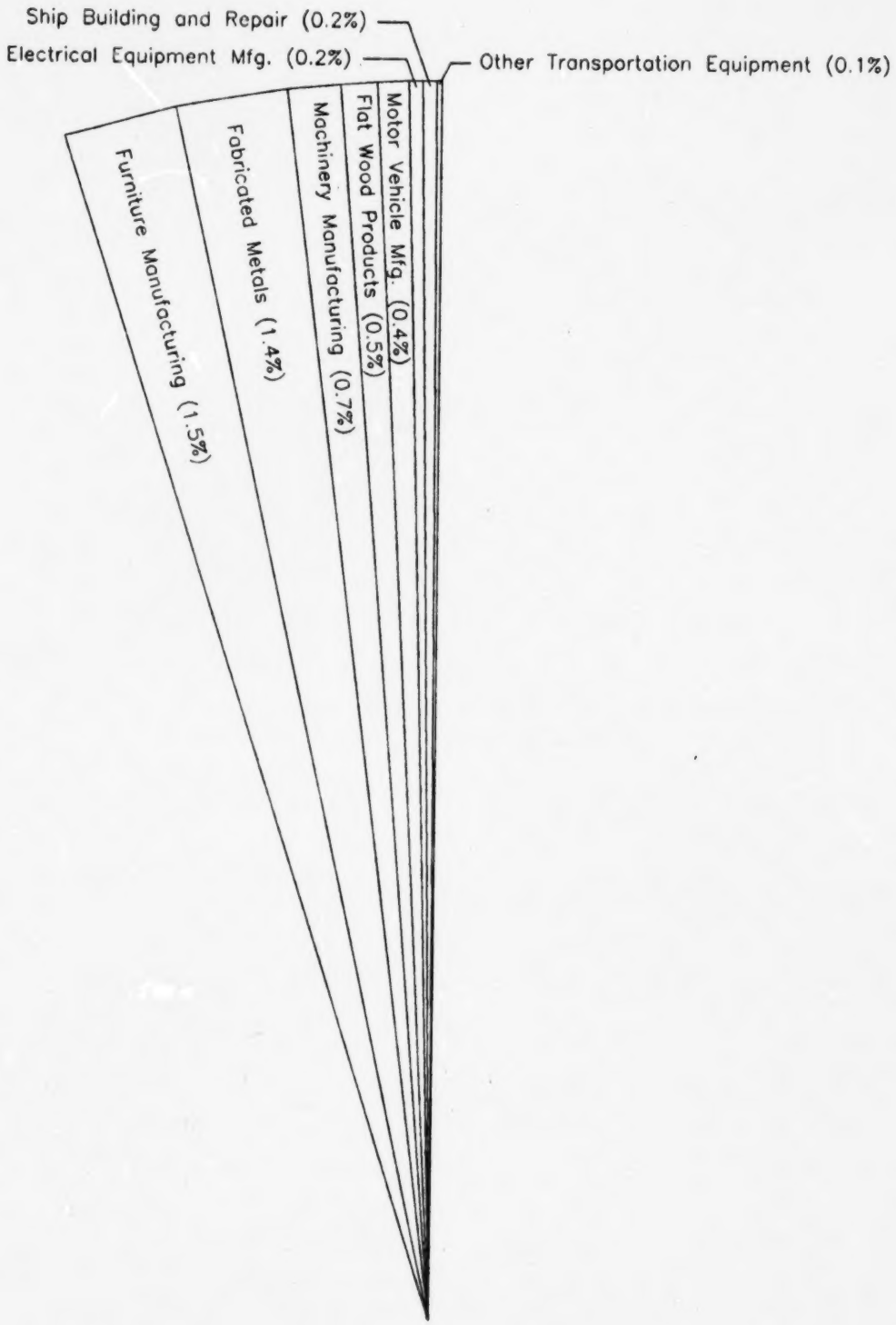

Figure 2.4-3. Solvent category emissions - Region VI. (continued)

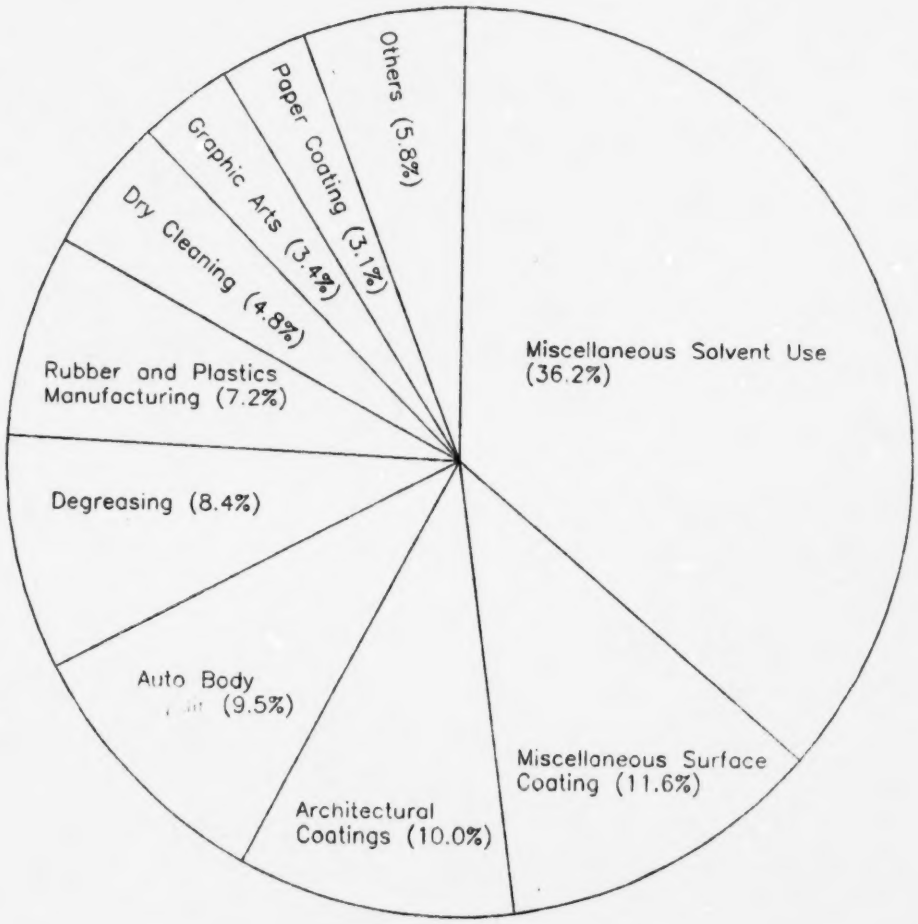

Figure 2.4-4. Solvent category emissions - Region IX.

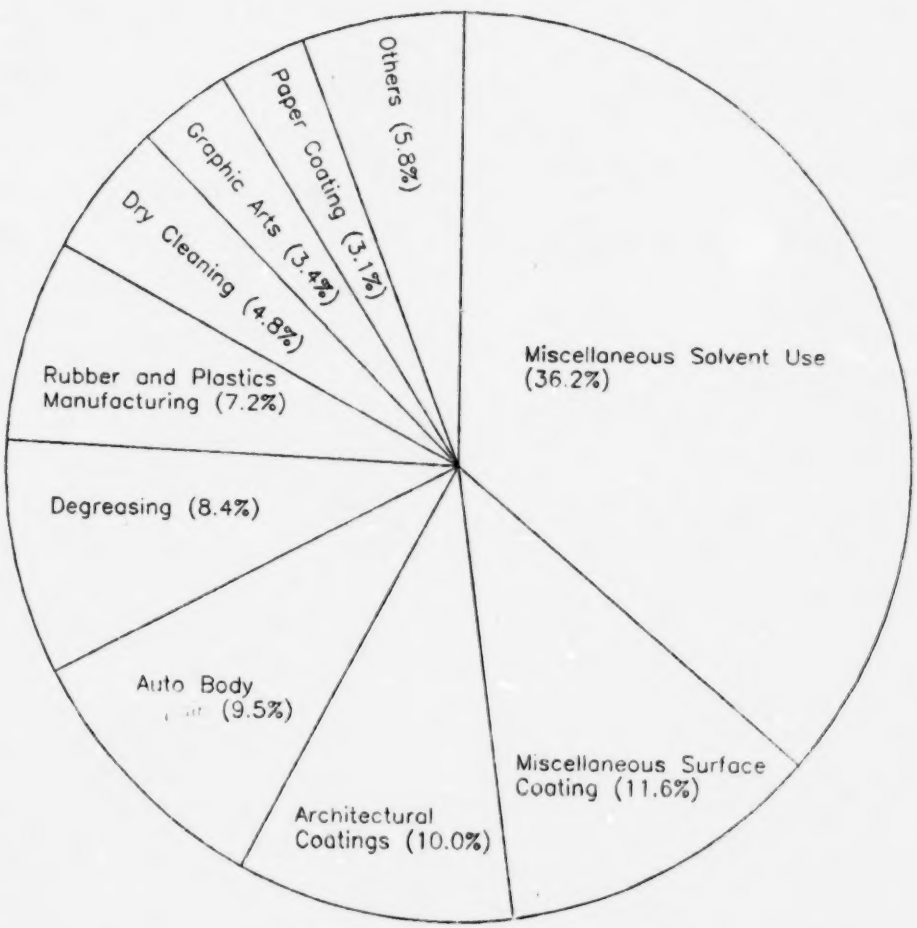

Figure 2.4-4. Solvent category emissions - Region IX.

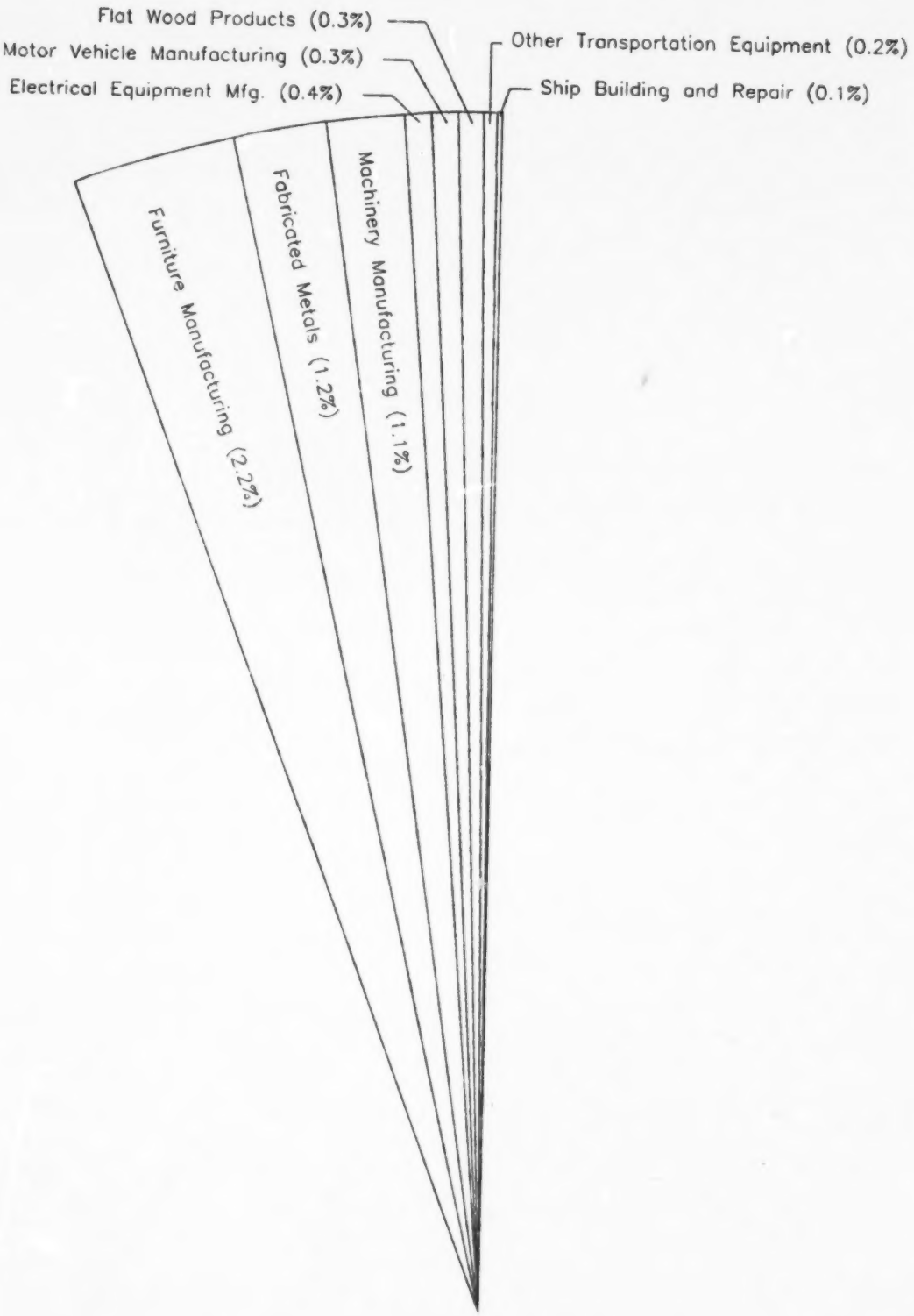

Figure 2.4-4. Solvent category emissions - Region IX. (continued)

3.0 VARIABILITY AND VALIDITY OF ESTIMATES

3.1 INTRODUCTION

One goal of this study was to identify the variability and analyze the validity of the emission estimates. Emission estimates for a given area source category can vary drastically depending on the estimation method used. In general, the so-called "top-down" methodologies used by National Emissions Data System (NEDS)/National Acid Precipitation Assessment Program (NAPAP) provide less accurate estimates than the "bottom-up" methodologies suggested in documents such as Procedures for the Preparation of Emission Inventories for Precursors of Ozone.[1] However, the "top-down" methodologies have the advantage of being less time- and resource-intensive than the "bottom-up" methodologies. When performing an emission inventory, the inventorying agency must weigh the costs and benefits of each kind of methodology in light of its resource constraints and must evaluate the validity of the individual methodologies available to it.

In Section 3.2, NEDS/NAPAP emission estimates for four counties in Texas are compared with emission estimates calculated for an emissions trends analysis which used other estimation methodologies for the same four counties and year. The purpose of this comparison is to show that these methodologies, all accepted as valid and recommended methodologies, can produce very different estimates. Section 3.3 discusses the variability and validity of the two sets of seasonal adjustment factors used to estimate summertime, or ozone season, emissions for area source categories. Section 3.4 discusses several "bottom-up" methodologies currently suggested for use by State and local agencies in preparing their State Implementation Plan (SIP) inventories.

3.2 COMPARISON OF NEDS/NAPAP AND TEXAS ESTIMATES

In a recent project sponsored by the U.S. Environmental Protection Agency (EPA) Region VI and the State of Texas, Alliance Technologies Corporation prepared an area source inventory of volatile organic compound (VOC) and nitrogen oxides (NO_x) emissions for four counties in Texas (Dallas, El Paso, Harris, and Tarrant) for the years 1978 through 1988.[5] The majority of the methodologies used to create this area source inventory (herein referred to as

the Texas trends analysis) are found in the document entitled Procedures for the Preparation of Emission Inventories for Precursors of Ozone. This "bottom-up" emissions inventory for 1986 was compared to the "top-down" 1986 NEDS/NAPAP emissions inventory results. Any major differences in emission estimates were addressed and the methodologies used to calculate the estimates reviewed. These items are outlined below.

(It should be noted that the "bottom-up" methodologies used in the Texas trends analysis are still rather generalized methodologies. They were used for the Texas trends analysis because they were less resource-intensive than some of the other methodologies given in Procedures for the Preparation of Emission Inventories for Precursors of Ozone. While in some cases these generalized methodologies may provide more accurate emission estimates than the true "top-down" methodologies used by NEDS/NAPAP, they are still less accurate than the recommended SIP methodologies discussed in Section 3.4.)

Table 3.2-1 shows the area source categories of VOC emissions and the associated emission estimates from both NEDS/NAPAP and the Texas trends analysis. The numbers given are the totals of emissions for all four counties within a source category. Because the area source categories found in NEDS/NAPAP do not match exactly with the area source categories outlined in Reference 1, only selected categories are shown in Table 3.2-1.

3.2.1 Structural Fires

The Texas trends analysis estimate of emissions from structural fires (2,021 tons VOC) is approximately 2.2 times the NAPAP estimate (931 tons VOC). The emissions estimate calculated for the Texas trends analysis was determined by assuming that six fires occur for every 1,000 people and multiplying this figure by an emission factor (107 pounds VOC per fire). The number of structural fires per year to be used in the NEDS/NAPAP calculations can be estimated either by using National Fire Prevention Association figures or by assuming that four fires occur per 1,000 people. If NEDS/NAPAP used the latter methodology (assuming four fires per 1,000 people) with the emission factor from the Office of Air Quality Planning and Standards (OAQPS) Technical Tables[6] and population figures from the U.S. Bureau of the Census, the emissions estimate would be as follows:

Total Population for Counties, 1986 = 6,294,500

Emission Factor = 107 lbs VOC per fire

$$6{,}294{,}500 \times \frac{4 \text{ fires}}{1{,}000 \text{ people}} \times \frac{107 \text{ lbs VOC}}{\text{fire}} \times \frac{1 \text{ ton}}{2{,}000 \text{ lbs}}$$

= 1,347 tons VOC per year

The actual NEDS/NAPAP estimate of 931 tons of VOC suggests that the former methodology using National Fire Prevention Association figures may have been employed. If, however, the latter methodology (shown in the above example) was used, the difference between the trends analysis and NEDS/NAPAP estimates may be due to either of the following: (1) the trends analysis assumption of six fires per 1,000 people (rather than four fires per 1,000 people), thus increasing the estimate despite using the same basic methodology; or (2) the use of different population figures.

3.2.2 Fuel Combustion

NEDS/NAPAP emissions estimates for residential fuel combustion and commercial/institutional fuel combustion are greater than the Texas trends analysis estimates. The NEDS/NAPAP residential fuel combustion emissions are 1,239 tons VOC, as compared to 928 tons VOC from the trends analysis, and the NEDS/NAPAP and Texas trends analysis commercial fuel combustion emissions are 262 and 176 tons VOC, respectively. NEDS/NAPAP commercial estimates are approximately 1.5 times the Texas trends analysis estimates; NEDS/NAPAP residential estimates are approximately 1.3 times the Texas trends analysis estimates.

The methodology used in the Texas trends analysis to calculate emissions from small stationary residential and commercial/institutional sources differs slightly from the methodology given in Procedures for the Preparation of Emission Inventories for Precursors of Ozone. While residential wood and coal use estimations follow the equations outlined in Reference 1, residential natural gas use was determined by multiplying the number of units using natural gas by the average natural gas consumption per residential customer

per year. Residential distillate oil use was determined by apportioning State fuel use on a county population percentage basis.

The Texas trends analysis did not calculate industrial fuel use, assuming that this category was covered by the point source inventory. Total emissions from this category not covered in the point source inventory would most likely be small. Commercial/institutional fuel use was calculated only for natural gas and distillate oil. The same methodology used for residential distillate oil use was employed for commercial/institutional natural gas and distillate oil use.

3.2.3 On-Site Incineration

The large relative difference between the NEDS/NAPAP estimate for on-site incineration (3,322 tons VOC) and the Texas trends analysis estimate (399 tons VOC) warrants close examination of the estimation methodologies involved. The Texas trends analysis used U.S. Bureau of Census population figures and average Regional factors for the residential, commercial/institutional, and industrial categories for the number of tons burned per year per 1,000 people or per 1,000 manufacturing employees. These Regional factors were not updated to reflect 1986 conditions from those factors given in Reference 1. Using the number of tons of waste burned calculated by the methodology in Reference 1 and emission factors from AP-42,[7] the Texas trends analysis estimate is 399 tons VOC per year. This is approximately one order of magnitude below the NEDS/NAPAP estimate although the basic NEDS/NAPAP methodology is the same as the methodology used in the Texas trends analysis.

It is possible that some of the difference in the estimates may be attributed to the Regional factors used to estimate the tons of solid waste burned in on-site incinerators. While NEDS/NAPAP updates the factors yearly, these factors were not updated from Reference 1 for use in the Texas trends analysis. It is doubtful, however, that the large discrepancy in the estimates is due solely to the use of Regional factors which were not updated. The Regional factors themselves, and the procedures used to develop these factors, may not adequately represent the activity in this category.

3.2.4 Open Burning

The Texas trends analysis estimate for this category (2,441 tons VOC) is approximately half of the NEDS/NAPAP estimate (4,950 tons VOC). The Texas trends analysis estimate was generated using the methodology given in Reference 1. The factor used to estimate tons of solid waste disposal through open burning for the trends analysis was not updated for 1986 conditions as is suggested in the reference document. The NEDS/NAPAP methodology used to estimate emissions from open burning is basically the same as the Texas trends analysis methodology. As with the on-site incineration category, some of the difference in the estimates may be due to the NEDS/NAPAP use of an update factor applied to the Regional factor and the trends analysis use of a Regional factor that was not updated.

Another explanation for the difference in the emissions estimates could be the way the Regional waste generation factor for residential open burning is applied. According to Reference 1, the residential open burning factor is to be applied to the county's rural population only. Open burning is assumed to be banned in urban areas. If, in fact, open burning is allowed in the urban areas of Dallas, El Paso, Harris, and Tarrant Counties or if the waste generation factor is applied differently in the NEDS/NAPAP methodology, the trends analysis estimate would have underestimated the actual emissions from open burning.

3.2.5 Off-Highway Vehicles

The Texas trends analysis emissions estimate for off-highway vehicles was calculated to be 7,010 tons VOC and includes emissions from construction equipment, industrial equipment, farm equipment, and off-highway motorcycles. The NEDS/NAPAP estimate (15,157 tons VOC) also includes the subcategories listed above as well as lawn and garden equipment and snowmobiles. These additional subcategories may account for a small part of the difference in the emission estimates. (In a rough estimate for the Texas trends analysis, VOC emissions from lawn and garden equipment were less than five percent of the total emissions for the Off-Highway Vehicles category.)

Another factor accounting for the difference between the estimates may be the methodologies and emission factors used to calculate emissions from each

subcategory. While emissions from construction equipment, industrial equipment, and farm equipment were estimated for the Texas trends analysis using methodologies found in Procedures for the Preparation of Emission Inventories for Precursors of Ozone and AP-42 emission factors, emissions from off-highway motorcycles were not. The methodology for estimating off-highway motorcycle emissions found in Reference 1 uses AP-42 emission factors which require detailed information on either motorcycle engine characteristics or motorcycle age. Because these data were not available for the Texas trends analysis, the trends analysis methodology used emission factors found in the NAPAP emission factors table under category 039 (Off-Highway Gasoline Vehicles).

3.2.6 Railroads

The emissions estimates calculated by NEDS/NAPAP (6,937 tons VOC) and the Texas trends analysis (5,255 tons VOC) differ by 1,142 tons. The estimation methodologies used to generate these estimates are outlined briefly below.

The Texas trends analysis methodology for calculating emissions from railroads differs from the suggested methodology in Reference 1 in that the data necessary to use the suggested methodology were not available. Because these data, miles of track per county, were unavailable, county fuel use by railroads was determined by apportioning State fuel use by railroads on the basis of manufacturing employees (Standard Industrial Classification Codes (SICs) 20 through 39). The NEDS/NAPAP methodology used to estimate distillate oil use by railroad locomotives allocates fuel use to the county level on the basis of current population distribution. This difference in the basis for allocation (population versus manufacturing employment) may account for the difference in the emission estimates.

3.2.7 Gasoline Vessels

The difference between the gasoline vessel emission estimates from NEDS/NAPAP and from the Texas trends analysis (849 tons VOC and 11,027 tons VOC, respectively) is over one order of magnitude, although the methodology used in the trends analysis to calculate motorboat fuel consumption is very

similar to the NEDS/NAPAP methodology. Fuel consumption is calculated in the manner shown below.

Inboard Gasoline
Consumption (gal/yr) = # Registered Inboards x 3 gal/hr x 10 (C) hr/yr

Outboard Gasoline
Consumption (gal/yr) = # Registered Outboards x 1.5 gal/hr x 10 (C) hr/yr

(C is a climatic factor which accounts for a longer pleasure boating season in warmer areas.)

In the NEDS/NAPAP methodology, State fuel consumption for this category is calculated and allocated to the county on the basis of inland water area (as is suggested in Reference 1). However, because data on county inland water area were not available, the Texas trends analysis methodology used county boating registrations (rather than State boating registrations, as given in the above equations) and assumed that all boats registered within a county were used only in that county.

The assumption mentioned above may account for the difference in the emission estimates as it may misrepresent where emissions from gasoline vessels actually occur. Boat owners often dock their vessels at marinas which are not in the county in which the owner lives. Using county boating registrations to determine county emissions can overestimate emissions in one county and underestimate emissions in another. Therefore, if the data are available, county inland water area should be used to estimate gasoline vessel emissions, as this data will provide a more reliable estimate.

3.2.8 Gasoline Marketed

The NEDS/NAPAP estimate for VOC emissions due to gasoline marketing activities (36,583 tons VOC) is approximately 1.6 times the Texas trends analysis estimate (22,181 tons VOC). In the Texas trends analysis, this category includes auto refueling, gasoline unloading, and gasoline tank trucks in transit. Emissions from automobile refueling were calculated by applying an emission factor to gasoline throughput. Gasoline throughput per county was

determined by apportioning the State total to the county on a population basis. Emission factors for displacement and spillage were taken from AP-42.

Emissions from tank trucks in transit were calculated by applying emission factors to the number of gallons transported. The number of gallons transported per county was determined by apportioning the State total for gallons distributed to the county on a population basis and multiplying that figure by a factor of 1.25. Emission factors for trucks returning with vapor and loaded with product were taken from AP-42.

Emissions from tank truck unloading were calculated by applying a typical loading loss factor to gasoline throughput. Gasoline throughput per county was determined by apportioning the State total to the county on a population basis. Loading loss (L_L) was determined by the following equation:

$$L_L = 12.46 \times \frac{(\text{Saturation Factor})(\text{True Vapor Pressure of Gasoline})(\text{Molecular Weight of Gasoline Vapors})}{\text{Temperature of Gasoline}}$$

The following assumptions, based on information found in AP-42, were used: (1) saturation factor = 1.0; (2) true vapor pressure of gasoline = 5.2 psia; (3) molecular weight of gasoline vapors = 66; and (4) temperature of gasoline = 528°R. The loading loss was then calculated to be 8 pounds of VOC per thousand gallons.

Differences in the emission estimates may be the result of the various assumptions used in the Texas trends analysis calculations.

3.2.9 Solvents Purchased

The Texas trends analysis estimate of solvents purchased emissions (61,219 tons VOC) is less than one-half the NEDS/NAPAP estimate (131,453 tons VOC). The Texas trends analysis includes the following subcategories under the main category of solvents purchased: architectural surface coating; automobile refinishing; cold cleaning degreasing; commercial/consumer solvent use; cutback asphalt paving operations; dry cleaning; graphic arts; and pesticides. The NEDS/NAPAP estimate is assumed to include NAPAP Source Classification Code (SCC) subcategories 078 through 094.

Methodologies found in Procedures for the Preparation of Emission Inventories for Precursors of Ozone were used for all of these subcategories except cutback asphalt paving operations. Emissions from cutback asphalt paving operations were calculated by determining the diluent content of the cutback and estimating the percent of the diluent that evaporates, and applying this figure to the tons of cutback asphalt used. Asphalt used in each county was apportioned on the basis of county population as a percent of State population. It was assumed that the average diluent content was 35 percent and that an average of 70 percent of the diluent evaporates. State totals of cutback asphalt were obtained from Asphalt Usage - United States and Canada,[8] a publication of the Asphalt Institute.

The major reason for the difference in the estimates is that all the subcategories included by NEDS/NAPAP in the solvents purchased category were not identified and were not estimated and included in the Texas trends analysis estimate. Other factors contributing to the differences in the emissions estimates include the use of different methodologies and the application of local control regulations to the emissions for this category. Regulations limiting emissions from certain sources, for example, degreasing and dry cleaning, were taken into consideration in the trends analysis calculations, but may not have been considered in the NEDS/NAPAP estimates.

3.3 ROMNET AND NAPAP SEASONAL ADJUSTMENT FACTORS

Seasonal (summer) adjustment factors have been developed for certain area source categories and States for the Regional Oxidant Modeling for Northeast Transport (ROMNET) program. All States in Region I (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont) and Region II (New Jersey and New York) are included in the ROMNET study area. Summer adjustment factors were developed for the following categories: pleasure boating/gasoline vessels (SCC 052); gasoline service stations (SCC 054); trade paints/architectural surface coatings (SCC 082); pesticides (SCC 094); bulk gas terminals (SCC 103); and hazardous waste treatment, storage, and disposal facilities (SCC 109). These factors were substituted for NAPAP seasonal adjustment factors (where appropriate) and emissions were recalculated for the area source categories affected.

For categories for which there were no ROMNET factors, NAPAP factors were retained for calculating emissions. After calculating emissions using the available ROMNET factors, the categories were then reranked to identify the effects of the ROMNET factors. The results of the reranking are shown in Tables 3.3-1 and 3.3-2 where rankings of the top seven categories for annual emissions, summer emissions using NAPAP factors, and summer emissions using ROMNET factors are compared. The summer rankings using ROMNET factors are based on emission estimates in which ROMNET factors were used only for SCC categories 052 and 054.

NAPAP summer emissions and ROMNET summer emissions were estimated only for those categories which are the top seven categories with respect to annual emissions within each State. If summer emissions were calculated for all area source categories, the ranking of the top seven categories would differ from those given here. For example, residential wood fuel combustion and cutback asphalt paving operations would most likely be replaced by other categories.

Rankings in the top seven categories using ROMNET summer factors did not differ from rankings using NAPAP factors in several States including the following: Connecticut; Massachusetts; New Hampshire; Rhode Island; New Jersey; and New York. Regional rankings for both Region I and Region II were also the same using the two groups of factors. Maine and Vermont showed distinct differences in the summer rankings. The major categories involved are Evaporative Loss - Gasoline Marketed (SCC 054) for Maine and Gasoline Vessels (SCC 052) and Evaporative Loss - Gasoline Marketed (SCC 054) for Vermont.

3.3.1 Basis of ROMNET Factors

The summer adjustment factors developed for gasoline vessels (pleasure boating) were based on the identification of an average "C" factor, which is a climatic factor used to account for a longer pleasure boating season in warmer areas. "C" is the number of months where temperature exceeds: 45°F for counties north of 43° latitude; 48°F for counties between 37° and 43° latitude; and 55°F for counties south of 37° latitude.[1] An average "C" factor was identified for each State using available meteorological station data, and 100 percent of pleasure boating activity was assumed to occur during this time.

Summer adjustment factors for pesticide use were developed by identifying the length of the growing season for each State and assuming that 75 percent of the pesticide application activity takes place during the growing season. For architectural surface coating (trade paints), it was assumed that 100 percent of the activity would take place when temperatures exceed 50°F. In this case, the climatic factor "C" was used to account for the number of months where the temperature exceeds 50°F for each State.

ROMNET summer adjustment factors for service stations, bulk gas terminals, and hazardous waste treatment, storage, and disposal facilities were developed using average summer temperature and Reid vapor pressure.

3.3.2 Basis of NAPAP Factors

According to the information available in Reference 2, the current NAPAP (Version 5.2) temporal allocation factors were derived from three sources: (1) the NECRMP (Northeast Corridor Regional Modeling Project) inventory effort;[9] (2) the NAPAP Version 4.2 inventory effort;[10] and (3) new research. The first step in completion of the NAPAP Version 5.2 factors was a review of each set of factors created for the earlier NECRMP and NAPAP Version 4.2 inventories. Based on this review, a decision was made to take one of three actions:

(1) Accept the NECRMP/NAPAP Version 4.2 factors without modification.

(2) Review the data sources used to compile the NECRMP/NAPAP Version 4.2 factors. If it was determined that the most accurate available data had been used, the factors were accepted without modification. If more accurate or more recently available data could make possible an improvement in the factors, new research was conducted and new factors were developed.

(3) Develop new factors. For a few categories where either the NECRMP or the NAPAP Version 4.2 factors had been based on engineering judgment or the importance of the emission category warranted the effort, new factors were developed after only a cursory review of the NECRMP and NAPAP Version 4.2 factors.

Sixteen area source emissions categories in the NAPAP Version 5.0 Inventory were not present in the earlier inventories. Eight of these categories represented minor variations of an existing category (e.g., a different fuel) and existing factors could be reviewed and used as

appropriate. New factors were developed for the remaining newly added categories.

The temporal allocation factors for a given area source category apply either to a single State, a group of States (e.g., an EPA Region), or the entire nation. This level of resolution for each category was determined by:

(1) Importance of the category in terms of emissions. Raw data were scanned; categories which contributed little to national emissions totals were generally given national resolution.

(2) Data availability. State- or Region-specific factors could not be developed where data were not available to support this resolution.

The following subsections contain descriptions of the development of the area source temporal allocation factors for selected categories.

3.3.2.1 Residential Fuel Combustion

Monthly average heating degree days for a representative meteorological recording station from each State were obtained from State, Regional, and National Monthly and Seasonal Heating Degree Days Weighted by Population.[11] These data were then used to develop the seasonal temporal factors for Residential Fuel Combustion (SCCs 001 - 006) for each State.

3.3.2.2 On-Site Incineration and Open Burning

Seasonal, daily, and hourly patterns were developed for On-Site Incineration and Open Burning (SCCs 021 - 026) from existing inventories including the following: Klemm and Brennan, 1981;[12] U.S. EPA, 1979a;[13] New Jersey Department of Environmental Protection, 1980;[14] New York Department of Environmental Conservation, 1980;[15] and U.S. EPA, 1980.[16]

3.3.2.3 Off-Highway Vehicles

State-specific seasonal emission patterns for Off-Highway Vehicles (SCCs 039 and 044) were derived from data contained in Highway Statistics.[17] Monthly distribution of off-highway motor fuel use was calculated by

subtracting monthly on-highway fuel use from total monthly fuel use. Seasonal allocation factors were then derived from the monthly patterns.

3.3.2.4 Vessels

Patterns for coal (SCC 049), diesel (SCC 050), and residual oil (SCC 051) powered vessels were developed from the EPA Guidelines.[18] For gasoline powered vessels (dominated by pleasure boats), the Guidelines recommended that seasonal patterns be based on the number of months that the mean temperature exceeds 45°F. These data were obtained from State, Regional, and National Monthly and Annual Average Temperatures Weighted by Area[19] and seasonal patterns were created as recommended.

3.3.2.5 Gasoline Marketed

The primary sources of information for the Gasoline Marketed category (SCC 054) were the U.S. Department of Energy's Petroleum Marketing Monthly[20] and the U.S. Department of Transportation's Highway Statistics. Analyses of these data yielded the conclusion that evidence was insufficient to justify using other than a uniform seasonal distribution.

3.3.2.6 Managed Burning, Agricultural Field Burning, Structural Fires, and Forest Wildfires

Managed Burning (SCC 061) and Agricultural Field Burning (SCC 062) used the patterns developed for field/slash burning in the NECRMP study. Structural Fires (SCC 064) were assumed to occur uniformly throughout the year. In the Forest Wildfires category (SCC 060), it was estimated that 90 percent of forest wildfires occur during summer or fall and that the remaining ten percent are split evenly between winter and spring.

3.3.2.7 Solvent Use Categories

U.S. Department of Labor statistics on 1980 working hours[21] were used to derive seasonal and daily temporal variations in the solvent use categories (SCCs 078 through 095). These data were broken down by SIC code and the NAPAP

emission categories were matched with the most appropriate code in the data set. Monthly data on total hours worked served as the basis for seasonal allocation factors.

3.3.3 Additional ROMNET Factors

Due to the scope of the ROMNET program, seasonal adjustment factors have been developed only for those States within the ROMNET study area. Therefore, the only Regions covered in both the ROMNET program and this study are Regions I and II. In its development of seasonal adjustment factors, the ROMNET program attempted to focus on those major emissions categories which were assumed to show some seasonal variation. In general, the differences seen when comparing the ranking of both annual and seasonal emissions between these two Regions are minor and the differences seen when comparing the NAPAP and ROMNET seasonal rankings are negligible. These differences are, however, more pronounced when comparing annual or seasonal rankings for either of these Regions to Region VI or Region IX.

If factors had been developed for States in Regions VI and IX using the same methodologies as were used to develop the factors for States in the ROMNET study area, differences between NAPAP and these new adjustment factor rankings would still, most likely, be minor. This is probably because the basic assumptions used to create the ROMNET and NAPAP factors are similar.

If additional ROMNET factors were developed for other area source categories, some minor differences may be seen in the comparison of seasonal rankings. This might occur due in part to the resources available (time, in particular) to develop the factors. If resources are constrained, the quickest or simplest methods would be used to develop the factors. This could lead to less accurate factors than the current NAPAP factors. Differences in the rankings might also be due to the way in which annual emissions are estimated and to the relatively small differences in tonnages between some categories.

3.4 SIP METHODOLOGIES FOR ESTIMATING AREA SOURCE EMISSIONS

In its guidance to State and local agencies (e.g., Reference 1), the EPA recommends several "bottom-up" methodologies to estimate emissions from area

source categories and suggests that the "bottom-up" methodologies provide more accurate estimates of emissions than do the "top-down" methodologies as used for the NEDS/NAPAP estimates. Two of the "bottom-up" methodologies which can be used to estimate area source emissions for SIP inventories include applying point source methods to area sources (small point sources) and surveying local activity. These methodologies are described in detail in Procedures for the Preparation of Emission Inventories for Precursors of Ozone and are discussed only briefly below.

3.4.1 Point Source Estimation Methods

Small sources may be handled as point sources rather than being surveyed collectively, especially for categories where collective activity level estimates are not easily available or reliable. Data for individual sources may be available from another data base within the agency (e.g., permit files) or from another agency. If these individual source data are not available from the above sources, questionnaires and surveys may be mailed to each facility to obtain source and emissions data.

In order to conduct this type of data gathering operation efficiently, the following steps should be implemented.

- Identify facilities to be surveyed - This can be accomplished through use of existing inventories, agency files, EPA/CTG (Control Techniques Guidelines) source listings, local industrial directories, manufacturers and suppliers, national publications, etc.
- Prepare mailing lists - The preparation of the mailing list is based on the information received and compiled from the first identification step.
- Design, assemble, and mail questionnaires - Depending on the resources available, either general or industry-specific questionnaires can be developed.
- Prepare and organize data handling procedures - Specific procedures for handling and organizing incoming data should be developed to ensure consistency.
- Establish response receiving systems - A questionnaire tracking system should be developed to determine the status of each facet of the mail survey. Procedures for recontacting sources should also be developed.

The inventorying agency must decide whether an individual point source record will be coded and maintained for each facility or whether the resulting individual activity levels will be collectively handled in the area source inventory. This decision will depend on (1) the resources available for the inventory and (2) whether the agency elects to handle source individually or collectively in the projection year inventory. In general, more accurate projections will result if sources are treated as point sources because individual control reductions can be estimated for each facility.[1]

3.4.2 Local Activity Level Surveys

The SIP guidance recommends the use local data rather than apportioning State or national data, where available, as the local data will provide a better estimate of the actual activity in the inventory area. Collective activity level estimates for a given category may be available from a local source, for example, a local trade association. Tax, highway, energy, and other State and local agency records may provide local collective activity level estimates for area source categories such as gasoline sales and marketing and cutback asphalt use. The inventorying agency should survey various local associations and agencies to determine the type of information that is maintained for the area and whether it can be used in the area source inventory. Reference 1 provides suggestions as to specific associations or agencies that may be contacted for selected area source activity level information.

3.4.3 Other Area Source Estimation Methods

Other area source estimation methods, for example, apportioning State or national totals to the local level, per capita emission factors, and emissions-per-employee factors, are often based on activity levels at the State or national levels. While these methodologies may be easier and less resource-intensive to use than other methodologies, the results may be less accurate.

Both per capita factors and emissions-per-employee factors can be made more locale-specific by basing the factors on a combination of local activity and population or employment in the specific area. Development of these local

factors may be dependent on the resources available to the inventorying agency. Use of local per capita factors and emissions-per-employee factors may produce more accurate estimates.

3.5 SUMMARY

The comparison of NEDS/NAPAP emission estimates and the Texas trends analysis emission estimates for four counties in Texas showed variations in estimates of over one order of magnitude in several categories (e.g., on-site incineration and gasoline vessels). A brief review of the methodologies used to calculate the emissions and an identification of possible causes for the variations in the emission estimates failed to account for most of the differences that were seen. Additional work is necessary to identify the causes for the variation in emission estimates using the accepted estimation methodologies and to assess the validity of the methodologies.

"Bottom-up" methodologies such as those described in Procedures for the Preparation of Emission Inventories for Precursors of Ozone provide more accurate estimates of emissions than dc the "top-down" methodologies used for NEDS/NAPAP inventory. These "bottom-up" methodologies, however, require a greater commitment of resources and their use may not be feasible for some inventorying agencies. Efforts should be made to bring the NEDS/NAPAP estimates more closely in line with the "bottom-up" estimates.

Despite the differences in the development and basis of the NAPAP and ROMNET seasonal adjustment factors, emission estimates generated using these factors are remarkably similar. Source category rankings remain almost the same when comparing the NAPAP and ROMNET results. It should be noted, however, that ROMNET summer adjustment factors have been developed only for a few categories. Development and application of ROMNET factors for additional source categories would most likely result in only minor changes in emissions and reranking of source categories.

TABLE 3.2-1. COMPARISON OF NEDS/NAPAP AND TEXAS TRENDS ANALYSIS VOC ESTIMATES FOR DALLAS, EL PASO, HARRIS, AND TARRANT COUNTIES, TEXAS

EMISSION SOURCE	VOC EMISSIONS[1] NEDS/NAPAP (tons/year)	TEXAS (tons/year)
Structural Fires	931	2,021
Fuel Combustion		
Residential	1,239	928
Commercial/Institutional	262	176
On-Site Incineration	3,322	399
Open Burning	4,950	2,441
Off-Highway Vehicles[2]	15,157	7,010
Railroads	6,397	5,255
Aircraft	4,996	5,162
Vessels		
Coal, Diesel, Residual	173	152
Gasoline	849	11,027
Gasoline Marketed[3]	36,583	22,181
Solvents Purchased[4]	131,453	61,219
SUBTOTAL	206,312	117,971
TOTAL NONMOBILE AREA SOURCES	212,547	118,444

[1]Emissions estimates are for calendar year 1986.

[2]For the Texas trends analysis, this category includes construction equipment, industrial equipment, off-highway motorcycles, and farm equipment. NEDS/NAPAP also includes lawn and garden equipment and snowmobiles.

[3]For the Texas trends analysis, this category includes auto refueling, gasoline unloading, and gasoline tank trucks in transit.

[4]For the Texas trends analysis, this category includes architectural surface coating, automobile refinishing, cold cleaning degreasing, commercial/consumer solvent use, cutback asphalt paving operations, dry cleaning, graphic arts, and pesticides.

TABLE 3.3-1. ANNUAL, NAPAP SUMMER, AND ROMNET SUMMER RANKINGS - REGION I

SOURCE CATEGORY (SCC)	CT			ME			MA			NH			RI			VT			REG I		
	A	SN	SR	A	SN	SR	A	SN	SR	A	SN	SR	A	SN	SR	A	SN	SR	A	SN	SR
Residential Fuel - Wood (006)	2	7	7	1	4	5	2	7	7	2	4	4	2	7	7	1	6	6	2	6	6
Residential On-Site Incineration (021)	6	5	5	7	7	7	5	5	5	6	6	6	5	5	5	7	7	7	5	5	5
Residential Open Burning (024)	7	6	6	6	6	6	7	6	6	5	5	5	7	6	6	4	5	4	7	7	7
Gasoline Off-Highway Vehicles (039)	4	3	3	5	3	4	4	3	3	4	3	3	4	3	3	5	3	3	4	3	3
Gasoline Vessels (052)	5	4	4	4	2	3	6	4	4	8	-	-	6	4	4	6	2	5	6	4	4
Evap Loss - Gasoline Marketed (054)	3	2	2	3	5	2	3	2	2	3	2	2	3	2	2	3	4	2	3	2	2
Evap Loss - Solvents Purchased (078-095)	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1
Cutback Asphalt Paving Oper (101)	8	-	-	8	-	-	8	-	-	7	7	7	8	-	-	9	-	-	8	-	-

Notes: A = Annual Emissions
SN = Summer Emissions Using NAPAP Factors
SR = Summer Emissions Using ROMNET Factors

TABLE 3.3-2. ANNUAL, NAPAP SUMMER, AND ROMNET SUMMER RANKINGS - REGION II

SOURCE CATEGORY (SCC)	NJ			NY			REG II		
	A	SN	SR	A	SN	SR	A	SN	SR
Residential Fuel - Wood (006)	2	5	5	2	5	5	2	5	5
Residential On-Site Incineration (021)	8	-	-	7	7	7	8	-	-
Residential Open Burning (024)	6	6	6	5	6	6	6	6	6
Gasoline Off-Highway Highway Vehicles (039)	4	3	3	4	3	3	4	3	3
Gasoline Vessels (052)	5	4	4	6	4	4	5	4	4
Evaporative Loss - Gasoline Marketed (054)	3	2	2	3	2	2	3	2	2
Evaporative Loss - Solvents Purchased (078-095)	1	1	1	1	1	1	1	1	1
Cutback Asphalt Paving Operations (101)	7	7	7	8	-	-	7	7	7

Notes: A = Annual Emissions
SN = Summer Emissions Using NAPAP Factors
SR = Summer Emissions Using ROMNET Factors

4.0 EVALUATION OF THREE AREA SOURCE SOLVENT CATEGORIES

4.1 IDENTIFICATION OF CATEGORIES

One of the goals of this study was to document inventory assumptions and reliability. In support of this goal, three area source solvent categories, Architectural Surface Coating (Source Classification Code (SCC) 082), Miscellaneous Surface Coating (SCC 093), and Miscellaneous Solvent Use (SCC 095), were identified for review of the National Acid Precipitation Assessment Program (NAPAP) methodologies used to estimate emissions. These three categories were chosen because of their relative importance in the area source solvent inventory. The following sections describe the historical background of the NAPAP estimates, the approach used for the 1985 inventory, and the reliability of the NAPAP estimates.

4.2 NAPAP DERIVATION OF ESTIMATES

The NAPAP methodology for area source solvent emissions is based on work performed by the Walden Research Division of Abcor, Inc. The Walden work was published as the U.S. Environmental Protection Agency (EPA) document entitled Methodologies for Countywide Estimation of Coal, Gas, and Organic Solvent Consumption[2] and was used as the basis for the solvent methodology used in the 1980 NAPAP inventory. This methodology was later updated for the 1985 NAPAP inventory and discussed in a document written by Alliance Technologies Corporation entitled Area Source Documentation for the 1985 National Acid Precipitation Assessment Program Inventory.[22] The following discussion is taken from these two documents.

4.2.1 Historical Approach

According to Walden, the identification and selection of major organic solvent groups for the purpose of estimating national consumption and subsequent countywide allocation were based on the results of a hydrocarbon pollutant systems study by M.S.A. Research Corporation (1972).[23] Table 4.2-1 shows a compilation of the primary industrial solvents that were considered. Of this list, the first sixteen solvent types were considered individually by

Walden, while the remaining solvent types were grouped together as "All Other Solvents." The category "Special Naphthas," which made up about two-thirds of the total organic solvent used in the country, included the aliphatic naphthas such as V. M. and P. naphthas, Stoddard solvents, rubber solvents, and mineral spirits.

Total U.S. production of solvents by type was extracted from the publication of the U.S. Tariff Commission entitled Synthetic Organic Chemicals, U.S. Production and Sales.[24] National production of special naphthas was taken from the U.S. Bureau of Mines publication entitled Minerals Yearbook.[25] Data pertaining to usage patterns for the sixteen most widely used organic solvents were obtained from two principal sources:

- Chemical Marketing Reporter,[26] which contains a weekly "Chemical Profile" for selected chemicals. These data were used to estimate the percentage of the solvent that is used by various industry groups.
- SRI's Chemical Economics Handbook,[27] which contains similar profiles on each chemical, but in greater detail. Data available from this publication included producing companies, historical production figures, consumption by markets (including a description of how and in which processes the chemical was used), historical cost figures, U.S. imports, foreign producing companies, and a list of references.

Descriptions of the basis for arriving at these 1971 consumption estimates for each of the main solvent groups are found in Appendix A. National usage is summarized in Table 4.2-2.

National consumption of organic solvents, distributed by major user categories, was apportioned to the individual counties on the basis of applicable Standard Industrial Classification (SIC) employment categories. The distributive factors for most user categories are the employment figures (identified by SICs) for the given category. Certain categories, for example, Trade Paints - Auto Refinishing and Other Miscellaneous user categories, use population or a combination of population and employment as the distributive factor. The distributive factors for county apportionment for architectural surface coatings, miscellaneous surface coatings, miscellaneous solvent use, and other source categories are shown in Table 4.2-3.

For the surface coating industry, the total solvent use was further subdivided according to the stratification of coating applications as shown in Figure 4.2-1. The reported production data by end use (see Figure 4.2-1) were

multiplied by solvent content factors to obtain solvent production estimates for surface coating uses. Average solvent contents were assumed as follows: water-based trade coatings - 3.5 percent by volume; solvent-based trade coatings - 53 percent by volume; and industrial coatings - 67 percent by volume. When the solvent production estimates for surface coating uses were applied to the national consumption estimates for all types of solvent, the secondary distribution percentages and consumption of the surface coating category were obtained. These results are given in Table 4.2.4.

National consumption of the primary solvent groups was distributed to each of the user categories according to the following equation:

$$S_{Nij} = S_i f_{ij} \qquad \text{(Equation 4.2-1)}$$

where S_{Nij} = national consumption (tons) of solvent group i by user category j

S_i = published total national solvent group i

f_{ij} = percent of solvent group i that is consumed by user category j

The county consumption for each solvent group and user category was computed and summed to give the total county consumption:

$$S_c = \sum_{i=1}^{17} \sum_{j=1}^{18} \frac{(E_{cj} - P_{cj})}{(E_{Nj} - P_{Nj})} S_{Nij} \qquad \text{(Equation 4.2-2)}$$

where S_c = total county organic solvent consumption (tons)

S_{Nij} = national consumption of solvent type i by user category j (tons)

E_{cj} = number of individuals (employment or population) in county c in user category j

E_{Nj} = number of individuals in the nation in user category j

P_{cj} = number of individuals in county c in point source user category j

P_{Nj} = number of individuals in the nation in point source user category j

The Walden study estimated consumption patterns for each of seventeen solvents among six application categories: surface coatings; degreasing; dry cleaning; printing and publishing; rubber and plastics; and other solvent use. The report recommended that these consumption patterns be periodically reviewed for two purposes: (1) the reclassification from "other solvent use" to one of the five specific categories; and (2) the reexamination of all the consumption patterns to account for petrochemical shortages and technological changes within the industry.

4.2.2 1985 NAPAP Approach

The basic procedure described above was also used in the 1985 NAPAP inventory although certain categories and percent distributions were updated. Using the algorithm developed by Walden, national consumption of the primary solvent groups was distributed to each of the user categories according to the percentage of total solvent consumptions used by the user category. Percentage usage obtained from published sources was compiled for each user category in Table 4.2-5. National area source solvent use estimates were determined by subtracting point source solvent use or emissions for each user category from total solvent use for each user category.

County consumption for each solvent group and user category was then computed by allocating calculated national area source consumption on the basis of applicable county SIC area source employment or population as shown in Table 4.2-3. County allocation for the Other Miscellaneous Solvent Use category was based on one-half county population plus one-half total industrial employment. To reflect the unequal solvent use in particular establishments within SIC groups, consumption was multiplied by a factor which compared the number of individuals in the county in each area source user category to the number of individuals in the nation in each area source user category. County consumption of each solvent type was then summed for each county to yield a total county consumption.

The reported national consumption of each solvent was extracted from the Department of Energy publication Petroleum Supply Annual[28] and the International Trade Commission (ITC) publication Synthetic Organic Chemicals. The percentage of each solvent consumed by each solvent-user category was obtained from Chemical Products Synopsis[29] and "Chemical Profiles" found in

the Chemical Marketing Reporter. Total employment and point source employment data were obtained from County Business Patterns.[30] County population was obtained from the Bureau of the Census' County Population Reports.[31]

Emission factors for the release of volatile organic compounds (VOC) assumed complete evaporation of all miscellaneous organic solvents (2,000 pounds VOC per ton of solvent used).

4.3 RELIABILITY OF ESTIMATES

The study of solvent use patterns in the Walden document estimated consumption patterns for each of seventeen solvents among the following six application categories: surface coatings; degreasing; dry cleaning; printing and publishing; rubber and plastics; and other solvent use. Walden recommended that these consumption patterns be periodically reviewed for reclassifying solvents from the Other Solvent Use category to one of the five specific categories and for reexamining all the consumption patterns to account for petrochemical shortages and technological changes within the industries involved.

The reliability of these estimates is dependent on the data used in the review suggested above, how recent the data are, and on how often the estimates are reviewed. Efforts are currently underway to review and update the methodology and procedures for the 1990 NAPAP inventory. Improvements being considered include the following: (1) increase the number of application categories to include additional solvent users; (2) increase the number of solvent types to be allocated over the solvent user categories; and (3) use VOC reactivity and speciation to characterize solvent types.

TABLE 4.2-1. INDUSTRIAL SOLVENTS

SOLVENT	SOLVENT
Special Naphthas	Turpentine
Perchloroethylene	Isopropyl Acetate
Ethanol	Ethyl Ether
Trichloroethylene	Monochlorobenzene
Toluene	Isopropanol
Acetone	Diethylene Glycol
Xylene	Methyl Acetate
Fluorocarbons	Cresols
Methyl Ethyl Ketone	Phenol
1,1,1-Trichloroethane	Chloroethane (ethyl chloride)
Methylene Chloride	Carbon Tetrachloride
Methanol	Pinene
Ethylene Dichloride	Cyclohexanol
Ethyl Acetate	Cyclohexanone
Cyclohexane	Ethyl Benzene
Methyl Isobutyl Ketone	Isobutyl Alcohol
Hexanes	Chloromethane
Benzene	n-Butylacetate
n-Butanol	Methyl Chloride
Nitrobenzene	

Source: Hydrocarbon Pollutant Systems Study, Volume 1, Stationary Sources Effect and Control, MSA Research Corporation, Evans City, Pennsylvania, October 1972.

TABLE 4.2-2. 1971 NATIONAL USE OF ORGANIC SOLVENTS

	Total Demand 1971 ($lbs x 10^6$)	Surface Coatings	Degreasing	Dry Cleaning	Printing & Publishing	Rubber & Plastics	Other Miscellaneous Solvent Use	Solvent Use As % of Total Consumption
Special Naphthas VM&P Solvent Stoddard Solvent Rubber Solvent Mineral Spirits	8,711	26%		6%	8%		60%	100%
Perchloroethylene	748		15%	58%			10%	83%
Ethanol	2,023	4%					35%	39%
Trichloroethylene	539		87%				3%	90%
Toluene	3,422	5%			5%			10%
Acetone	1,660	9%					16%	25%
Xylene	3,617	6%					7%	13%
Fluorocarbons	825					10%	55%	65%
M.E.K.	491	65%					7%	72%
1,1,1-Trichloroethane	375		67%			9%	11%	87%
Methylene Chloride	380	31%	11%			11%	>37%	>90%
Methanol	749						9%	9%
Ethylene Dichloride	7,558	0.3%				2%	2.7%	5%
Ethyl Acetate	159	70%		9%	8%	10%		97%
Cyclohexane	1,747	2%				2%		4%
M.I.B.K.	190	65%					25%	90%
All Other Solvents	11,456						5.16%	5.16%

TABLE 4.2-3. DISTRIBUTIVE FACTORS FOR ORGANIC SOLVENTS BY USER CATEGORIES

User Categories	Distributive Factor SIC Industry/Population
Surface Coatings	
Trade Paints-Auto Refinishing	County Population
Automotive Refinishing (Trade)	7537 (Paint Shops)
Automotive	3711-15 (Motor Vehicles)
Wood Furniture & Fixtures	2511-99 (Furniture & Fixtures)
Metal Furniture & Fixtures	2511-99 (Furniture & Fixtures)
Metal Containers	3411-99 (Fabricated Metal Products)
Sheet Strip & Coil	3411-99 (Fabricated Metal Products)
Appliances	3511-99 (Machinery, Except Electrical) 3611-99 (Electrical Machinery, Equipment & Supplies)
Machinery & Equipment	3511-99 (Machinery, Except Electrical) 3611-99 (Electrical Machinery, Equipment & Supplies)
Paper	2611-61 (Paper & Allied Products)
Factory-Finished Wood	2431-39 (Millwork, Plywood-Related Supplies) 2441-49 (Wood Containers)
Transportation (Non-Auto)	3721-28 (Aircraft & Parts) 3741-99 (Railroad Equipment, Bicycles, Motorcycles, Missiles, Space Vehicles, Miscellaneous)
Electrical Insulation	3611-99 (Electrical Machinery, Equipment & Supplies)
Other, Exterior, Interior	1911-3999 (Total Manufacturing)
Marine	3731-32 (Ship Building & Repair)

(continued)

TABLE 4.2-3. DISTRIBUTIVE FACTORS FOR ORGANIC SOLVENTS BY USER CATEGORY

(continued)

User Category	Distributive Factor SIC Industry/Population
Degreasing	3411-3999 (Metal Products, Machinery, Transportation Equipment, Instruments, Miscellaneous)
Dry Cleaning	2 x 7216 (Dry Cleaning, Except Rugs) 7215 (Coin-Op Laundries & Dry Cleaning) 7218 (Industrial Launderers)
Printing	2641-49 (Paper Products) 2651-55 (Paperboard Containers & Boxes) 2711-95 (Printing & Publishing)
Rubber & Plastics	3011-79 (Rubber & Plastics)
Other Miscellaneous	1/2 by 1911-3999 (Total Manufacturing) 1/2 by County Population

SURFACE COATINGS

Estimated Production Value and Production in 1970

(Millions of Dollars/Millions of Gallons)

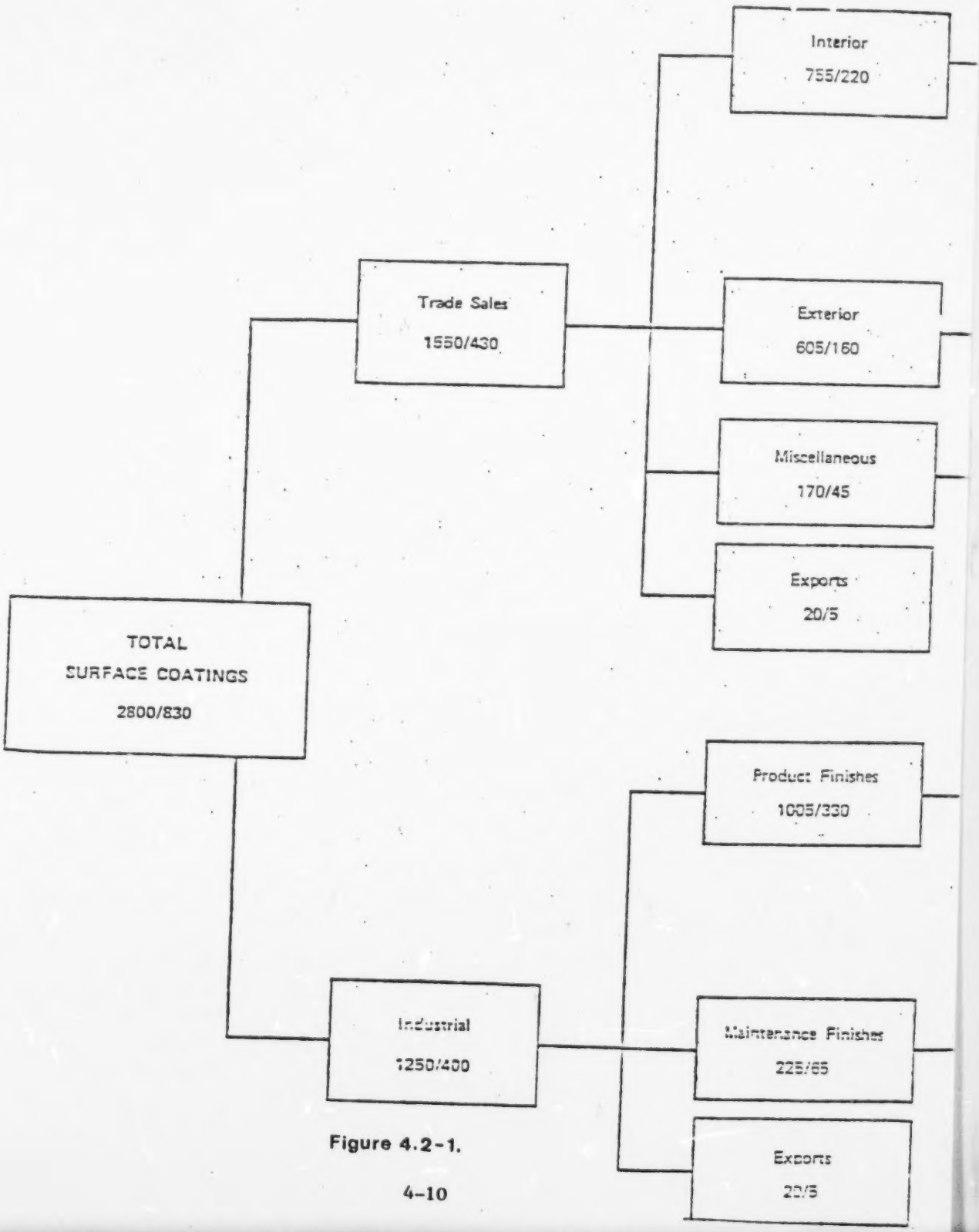

Figure 4.2-1.

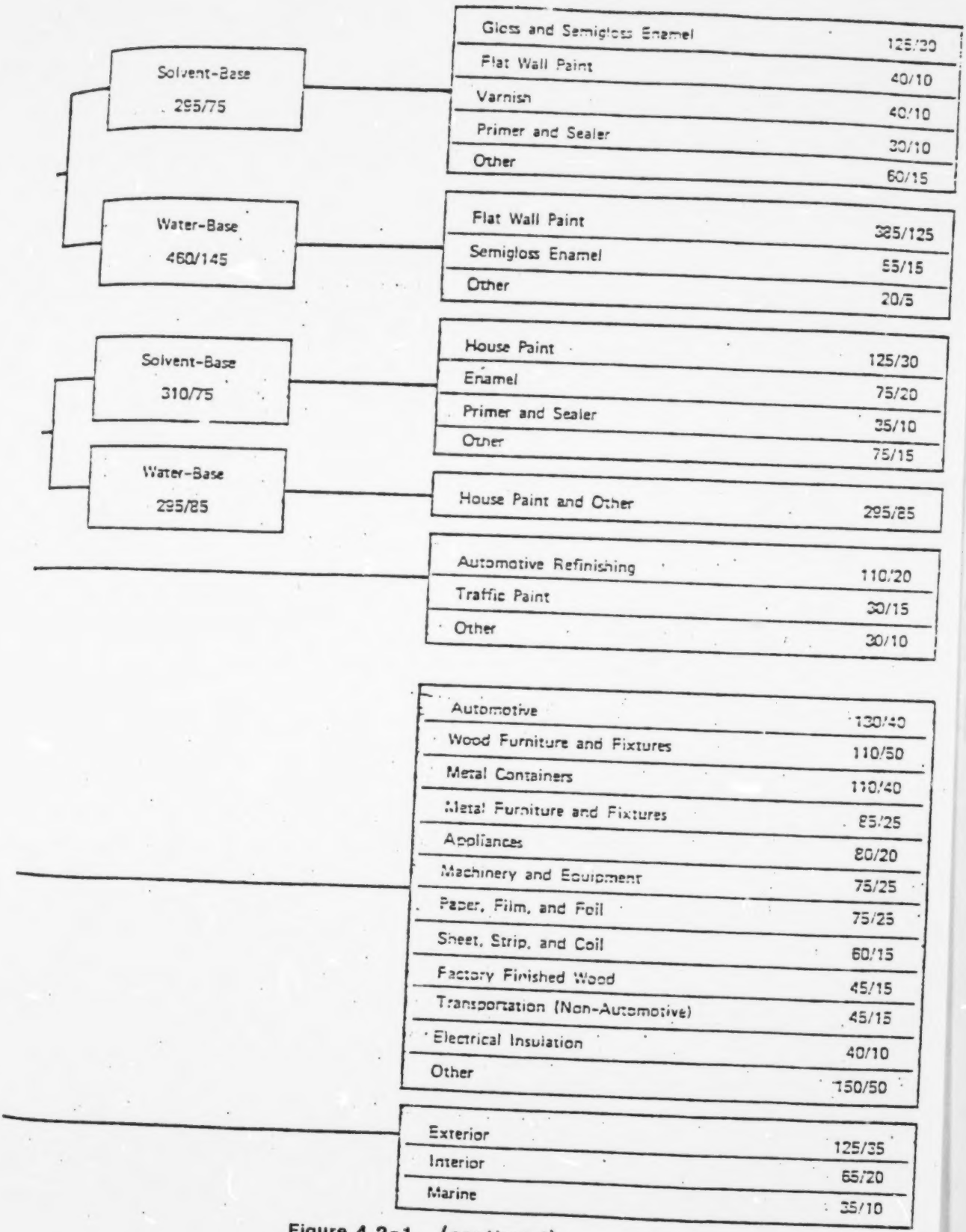

Figure 4.2-1. (continued)

TABLE 4.2-4. DISTRIBUTION FACTORS FOR SURFACE COATING SOLVENT USE 1971

Coating Usage Type	SIC Groups	% of Surface Coating Solvent Use
Trade Paints-Auto Refinishing	Population Distribution	26.8%
Auto Refinishing (Trade)	7535 Paint Shops	2.8%
Automotive	371 Motor Vehicles	7.1%
Wood Furniture & Fixtures Metal Furniture & Fixtures	25 Furniture & Fixtures	13.4%
Metal Containers Sheet Strip & Coil	34 Fabricated Metal products	9.8%
Appliances Machinery & Equipment	35 & 36 Machinery, Electrical Equipment & Supplies	8.0%
Paper	26 Paper & Allied Products	4.4%
Factory-Finished Wood	243, 244 Millwork, Plywood-Related Supplies, Wooden Containers	2.7%
Transportation (Non-Automobile)	37 Transportation Equipment Less 371 Motor Vehicles & 373 Shipbuilding Repair	2.7%
Electric Insulation	36 Electrical Equipment & Supplies	1.8%
Other, Exterior, Interior	Total Manufacturing Equipment	18.7%
Marine	373 Shipbuilding & Repiar	1.8%
	TOTAL	100%

TABLE 4.2-5. 1985 ORGANIC SOLVENTS BY END USE CATEGORY (%)

SOLVENT	Consumption (MM lbs)	Surface Coating	Degreasing	Dry Cleaning	Graphic Arts	Rubber/ Plastics	Misc. Industry	Other
Special Naphthas	7364	48.7	6.7	2.0	6.4	9.6	7.1	10.77
Perchloroethylene	595		10.0	53.0				4.0*
Ethanol	9087						26.0	
Trichloroethylene	180		80.0					5.0*
Isopropanol	1177	15.0					9.0	37.0
Acetone	1877	17.0						11.5*
Glycol Ethers	385***	43.0					10.0	
Cyclohexanone	40***						5.0	
Methanol Ethyl Ketone	508	69.0			4.0		10.0	
Ethyl Benzene	6700					54.0	4.0	0.5
Propylene Glycol	447						8.0	6.0
Methanol	12,197				5.0			15.0
Butyl Acetate	101	65.0				8.0		3.0
Ethyl Acetate	214	41.0					1.8	13.0
Butyl Alcohols	886	15.5					8.0	1.3
Methyl Isobutyl Ketone	148	65.0						18.0
Monochlorobenzene	233		21.0**				21.0**	11.0*
o-Dichlorobenzene	45						25.0	5.0*
p-Dichlorobenzene	64					23.0		46.0

* Not identified as solvent or non-solvent other.
** Equally distributed where unspeciated.
*** Consumption = Production + Imports - Exports (from Chemical Products Synopsis).

5.0 SUMMARY AND CONCLUSIONS

5.1 SUMMARY OF WORK PERFORMED AND RESULTS

Area source categories were prioritized based on annual volatile organic compounds (VOC) tonnages for each category as reported in the 1985 National Emissions Data System (NEDS)/National Acid Precipitation Assessment Program (NAPAP) inventory. The top seven categories for each State in Regions I, II, VI, and IX and for each of these four Regions were identified by tonnage, by percent of total nonhighway area source VOC, and by percent of total area source VOC (including highway mobile sources). NAPAP seasonal (summer) adjustment factors were then applied to the top seven categories and these categories were reranked based on the summer emissions estimates. These data were presented in a series of tables and pie charts in Section 2.0.

Based on the annual emissions estimates, the top three categories in all Regions are Evaporative Loss - Solvents Purchased, Residential Fuel - Wood, and Evaporative Loss - Gasoline Marketed. These categories show little Regional variation in ranking. The major difference in rankings when emissions are adjusted for the summer is the decreased importance of Residential Fuel - Wood. The Solvent Purchased category and the Gasoline Marketed category rank first and second, respectively, in all Regions in summer emissions.

In the next part of this study, the NEDS Evaporative Loss - Solvents Purchased category was disaggregated to the NAPAP source classification code (SCC) categories 078 through 095. These categories were also prioritized based on annual emissions and adjusted to reflect summertime conditions using NAPAP seasonal (summer) adjustment factors. The categories were then prioritized again based on the summer emissions. Tables and pie charts were also created for these data. Regional Oxidant Modeling for Northeast Transport (ROMNET) summer adjustment factors were substituted, where available, for the NAPAP factors and summer emissions were recalculated. Results of the comparison of summer rankings using the two different sets of factors showed very little change in the category rankings. The bases of the NAPAP and ROMNET seasonal adjustment factors were presented for all factors used in this analysis.

In an attempt to assess the validity of the NEDS/NAPAP VOC emissions estimates, these estimates for Dallas, El Paso, Harris, and Tarrant Counties in Texas were compared with estimates generated for a VOC/NO_x (nitrogen oxides) emissions trends analysis for the same counties and year. While emissions estimates for some categories were within a reasonable range of one another, other estimates differed by more than one order of magnitude. Estimation methodologies and assumptions were reviewed for several source categories and attempts were made to explain the causes of the differences in estimates.

Several "bottom-up" methodologies for estimating area source emissions were discussed in Section 3.3. While these methodologies are often more resource-intensive than the "top-down" methodologies employed for the NEDS/NAPAP inventory, the resulting estimates are more accurate and more representative of the area source category.

Three solvent categories (Miscellaneous Solvent Use, Miscellaneous Surface Coating, and Architectural Surface Coating) were selected for a detailed review of the basis of their annual NAPAP emissions factors. These categories were chosen because of their importance in the Evaporative Loss - Solvents Purchased category. The NAPAP derivation of estimates for these three categories was discussed in Section 4.2 (and in Appendix A) and the reliability of the estimates was addressed in Section 4.3.

5.2 RECOMMENDATIONS

NEDS/NAPAP area source methodologies should be reviewed and compared to the "bottom-up" methodologies suggested in the U.S. Environmental Protection Agency (EPA) guidance documents, for example, Procedures for the Preparation of Emission Inventories for Precursors of Ozone,[1] for use by State and local inventorying agencies. The variations in the emission estimates between these two inventory sources should be identified and resolved. Feasible and effective control measures to reduce emissions can not be applied effectively to the area source categories if the estimated emissions from the categories are misrepresented by either overestimation or underestimation.

The following recommendations are made for future work in the areas of emission estimation methodologies and disaggregation of major categories.

- Additional studies should be performed to compare emissions estimates generated using the EPA State Implementation Plan (SIP) guidance and the NEDS/NAPAP emissions estimates. If the findings of the additional studies support the findings of this project, all of the estimation methodologies should be reviewed and revised as warranted.

- Further disaggregation of the Miscellaneous Solvent Use category (SCC 095), especially the commercial/consumer solvent use portion of this category, should be attempted. Emphasis should be placed on how the solvents are apportioned to the various subcategories and on what can be done to improve this process. In addition, the updates to and revisions of the NAPAP methodology for the 1990 NAPAP inventory should be followed closely.

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APPENDIX A
NATIONAL USAGE OF ORGANIC SOLVENTS

INTRODUCTION

The following discussion is based on information found in Appendix E of the document by Walden entitled Methodologies for Countywide Estimation of Coal, Gas, and Organic Solvent Consumption (EPA-450/3-75-086, NTIS PB259909, December 1975) and describes the procedures used to develop the 1971 estimates of solvent consumption. A list of the references used in Appendix E of the above document is included at the end of this discussion.

The national consumption of the primary solvent groups, distributed by user category, was generated using data from the Chemical Marketing Reporter[1] and from SRI's Chemical Economic Handbook.[2] The primary solvent groups include the following compounds and groups of compounds: special naphthas; perchloroethylene; ethanol; trichloroethylene; toluene; acetone; xylene; fluorocarbons; methyl ethyl ketone (MEK); 1,1,1-trichloroethane; methylene chloride; methanol; ethylene dichloride; ethyl acetate; cyclohexane; methyl isobutyl ketone (MIBK); and all other organic solvents.

The national consumption figures are used for the countywide allocation of solvent consumption and are summarized in Table 4.2-2 of this document. Descriptions of the basis for arriving at the 1971 consumption estimates are given below for each of the main solvent groups identified in the previous paragraph.

SPECIAL NAPHTHAS

This group of organic solvents is widely used in both industrial and commercial uses and accounted for an estimated 59 percent of total organic solvent consumption for 1971. Estimates of the use of special naphthas in surface coatings were based on the figures for the SRI category of aliphatic hydrocarbons.[1] (This category is comparable to the Bureau of Mines category of special naphthas used in this report.)

The SRI estimate for aliphatics used in surface coatings was 700 million pounds; however, this figure did not account for solvents and thinners added by the users before application. To estimate the additional aliphatic

hydrocarbons, Walden used the distribution of chemical types used for surface coatings (see Figure A-1) and the SRI figure of 3,390 million pounds of total solvent use for surface coatings, and assumed that an equal amount of hydrocarbons was added by the user before application. The resulting estimate was calculated as follows:

$$(3{,}390 \times 10^6 \text{ lbs}) \times \left[\frac{700 \times 10^6 \text{ lbs}}{(700 \times 10^6 \text{ lbs} + 800 \times 10^6 \text{ lbs})}\right] = 1{,}582 \times 10^6 \text{ lbs}$$

By including the estimate for use of solvents and thinners, Walden determined that approximately 26 percent of special naphthas were consumed in surface coatings.

Use of special naphthas in the printing and publishing industry was derived from a 1969 survey of aliphatic solvent use in the graphic arts industries.[3] The reported aliphatic solvents from the survey were extrapolated to the national level on the basis of total employment in the graphic arts industries. The resulting estimate of 94 million gallons of solvents consumed represented 8.3 percent of the total demand for special naphthas for 1971.

The use of special naphthas (e.g., Stoddard solvent and safety solvent) in the dry cleaning industry was estimated to be approximately 55 million pounds for 1971. Information from Reference 4 indicated that the use of special naphthas in degreasing applications was negligible. Similarly, no data were available to estimate consumption of special naphthas by the rubber and plastics industry. The results of the special naphtha use analysis are shown in Table 4.2-2.

PERCHLOROETHYLENE

The use of perchloroethylene was derived from data in the Reference 2. Virtually all consumption of perchloroethylene in 1971 was for solvent use, as shown in Table 4.2-2. Approximately 17 percent of the perchloroethylene produced was exported.

ETHANOL

According to the Chemical Marketing Reporter, total solvent use of ethanol was 39 percent of total consumption. Four percent of all ethanol consumed in 1971 was used in surface coatings.[2] The remaining 35 percent of ethanol used as solvent was assigned to the "other miscellaneous solvent use" category in Table 4.2-2.

TRICHLOROETHYLENE

According to the Reference 2, 90 percent of total trichloroethylene demand was consumed in solvent uses; the remaining ten percent was exported. Only three percent of the total could not be assigned to a specific industrial process.

TOLUENE

Only about ten percent of the total toluene consumption was solvent use, according to Reference 2, and approximately half of this use occurred in the surface coatings industry. The remaining portion of toluene used as a solvent was assigned to the printing and publishing industry based on information recorded in the Hydrocarbon Pollutants Report.[5]

ACETONE

The Marketing Guide to the Chemical Industry[6] reported that 25 percent of all acetone consumption in 1971 was in solvent use. According to the Chemical Marketing Reporter, nine percent of the total consumption of acetone occurred in the surface coating industry. The remaining 16 percent of acetone in solvent use was assigned to the other miscellaneous solvent use category in Table 4.2-2.

XYLENE

The Reference 2 reported that 13 percent of the total demand of xylene in 1971 was consumed as solvent. The major application of xylene is as a solvent

in surface coatings. Because xylene and toluene are the two basic aromatic hydrocarbon solvents used in the surface coating industry, total toluene solvent use in the surface coating industry was subtracted from total aromatic hydrocarbon consumption in the industry (given in Figure A-1). The remainder represented roughly the consumption of xylene in the industry. Some small amounts of benzene (itself an aromatic hydrocarbon) are also used in the industry. However, the use of benzene is so small due to its toxicity[7] that its exclusion in the Walden report did not significantly affect the xylene consumption estimate.

FLUOROCARBONS

According to the Chemical Marketing Reporter, consumption of fluorocarbons as solvents was 65 percent of the total use of fluorocarbons for that year. Ten percent of the total was distributed to the rubber and plastics industry; the remaining 55 percent was assigned to the other miscellaneous solvent use category. The estimate of the percent of total fluorocarbons used as solvents reflected the use of fluorocarbons in manufacturing aerosols. No distinction was made in the Walden report between fluorocarbons released from aerosol cans or from solvent use. According to Walden, this distinction was unnecessary because the determination of organic solvent use in the report was only for the purpose of estimating area source emissions. No further distinction was needed. Therefore, fluorocarbons used in manufacturing aerosols are included in the inventory of solvent use.

METHYL ETHYL KETONE (MEK)

Reference 2 estimated that 65 percent of all MEK consumed in 1971 was for solvent application in the surface coating industry. An additional seven percent was consumed as solvent for non-specified uses and was included in the other miscellaneous solvent use category in Table 4.2-2.

1,1,1-TRICHLOROETHANE

According to the Chemical Economic Handbook, in 1971 1,1,1-trichloroethane was consumed in the following manner: 65 percent as a solvent in

degreasing operations; nine percent in rubber and plastics production; and eleven percent in other non-specific solvent uses (i.e., miscellaneous solvent use).

METHYLENE CHLORIDE

Reference 1 reported that 31 percent of all methylene chloride consumed in 1971 was used as solvent in surface coating, eleven percent as solvent in degreasing operations, and eleven percent as solvent in the rubber and plastics industry. Approximately 20 percent of the total consumption was used in the aerosol industry and was, therefore, included as miscellaneous solvent use. The remaining 27 percent was also listed as miscellaneous solvent use. However, further investigation revealed that less than ten percent of the miscellaneous category was exported.[8] Total consumption of methylene chloride for solvent use was, therefore, listed as greater than 90 percent.

METHANOL

The Chemical Marketing Reporter listed nine percent of total methanol consumption in 1971 for non-specified solvent use. This is represented in Table 4.2-2 as other miscellaneous solvent use.

ETHYLENE DICHLORIDE

Solvent use of ethylene dichloride in 1971 was reported in Reference 1 as follows: three percent of all ethylene dichloride produced was consumed as solvent in surface coating; two percent of all ethylene dichloride produced was consumed in the rubber and plastics industry; and 2.7 percent of all ethylene dichloride produced was employed in non-specified solvent use.

ETHYL ACETATE

Approximately 97 percent of all ethyl acetate produced in 1971 was consumed as solvent.[1] This total is distributed to four industries: surface coating - 70 percent; dry cleaning - nine percent; printing and publishing - eight percent; and rubber and plastics - ten percent.

CYCLOHEXANE

Reference 2 reported that two percent of all cyclohexane consumed in 1971 was used as solvent in the surface coating industry, and an additional two percent was used as solvent in the rubber and plastics industry.

METHYL ISOBUTYL KETONE (MIBK)

According to the Chemical Marketing Reporter, 65 percent of all MIBK consumed in 1971 was used in the surface coating industry, and 25 percent was consumed in other non-specified solvent uses.

ALL OTHER ORGANIC SOLVENTS

This category includes the following compounds and groups of compounds: hexanes; benzene; N-butanol; nitrobenzene; turpentine; isopropyl acetate; ethyl ether; monochlorobenzene; isopropanol; diethylene glycol; methyl acetate; and cresols. Their total consumption in 1971 was 11,456 million pounds.[9] In 1968, about 5.2 percent of the total consumption of these chemicals was used as solvents.[5] Applying this to the 1971 consumption total, a figure of 591 million pounds was derived for total solvent use in this category. This figure is less than four percent of the total of all solvent use covered in the Walden study.

In order to determine any change in the solvent usage pattern, the total solvent use estimates of M.S.A. Research Corporation for the year 1968 were compared with these estimates for the year 1971, as shown in Table A-1. The category of special naphthas was 100 percent for both estimates because both studies used the Bureau of Mines' definition for this category. (This definition was naphthas used as solvents.) The two chemicals which showed wide variations in their usage pattern between 1968 and 1971 were ethane and fluorocarbons. This discrepancy may be explained by the rapid increase of their use in the production of aerosols.[1] In general, the solvent use estimates found in the Walden report agreed fairly well with those of M.S.A. Research.

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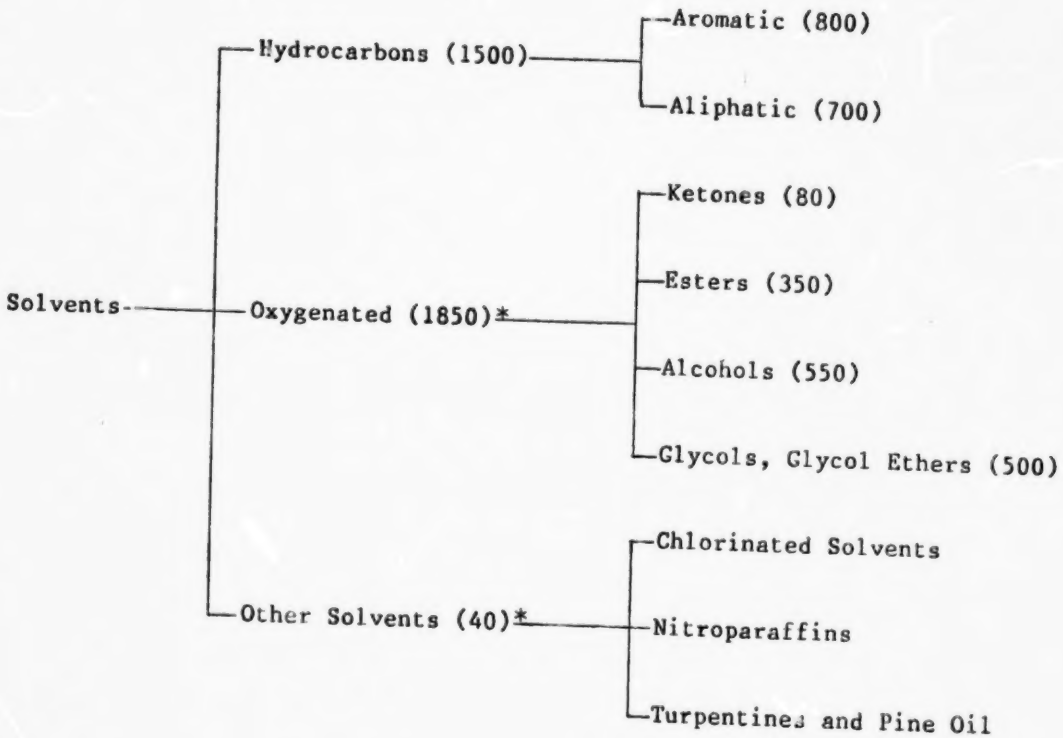

*Values associated with compounds in the "Oxygenated" category do not sum to 1850. In addition, no values were assigned to the compounds in the "Other Solvents" category. Attempts to contact the authors regarding these discrepancies were unsuccessful. Examination of the EPA Project Officer's files provided no additional information.

Figure A-1. Surface coatings industry raw materials used (million pounds).